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FEDERAL ON-SCENE COORDINATOR'S REPORT

**TROWBRIDGE ESTATES MERCURY SITE
SOUTHAMPTON TOWNSHIP, BUCKS COUNTY, PENNSYLVANIA**

**CERCLA REMOVAL ACTION
June 23 through June 27, 1987**



**UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY**

AR100005

Trowbridge Estates Mercury Site
Federal OSC Report

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REGION III
CERCLA REMOVAL ACTIVITY

PROJECT #173

FACTS SHEET

SITE: Tates Mercury Site

SIZE: Approximately 400 square feet

LOCATION: Pottsville, Bucks County, Pennsylvania

APPROVAL: June 23, 1987

PROJECT: June 23, through June 27, 1987

DESCRIPTION: The site consisted of a residential back yard in a condominium development known as Trowbridge Estates. The initial assessment by TAT revealed elemental mercury in large quantities on the ground surface of the Zhivalyuk property. As a result, the OSC activated his \$50K Delegation of Authority to initiate an emergency removal action. Ten drums of contaminated soil were removed from the property. No source of the mercury contamination could be identified.

HAZARDOUS MATERIAL: Elemental mercury

QUANTITIES REMOVED: 10 drums (approximately 5000 pounds) of contaminated soil

OSC: Garrett H. Arai

REMOVAL CONTRACTOR: The Guardian Company (ERCS subcontractor of O.H. Materials, Inc.)

DISPOSAL LOCATION: Chem Waste Management, Emelle, Alabama; RCRA #PAP000000105

PROJECT CEILING: \$50,000 (Delegation of Authority 14-1-A 5/1/85)

PROJECT COST: \$13,529 (Estimated)

COMMENTS:

Garrett H. Arai, OSC

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FOREWORD

This report is submitted in accordance with procedures outlined in the National Oil and Hazardous Materials Contingency Plan. The primary thrust of the Plan is to provide a coordinated Federal response capability at the scene of an unplanned or sudden discharge of oil or hazardous substance that pose a threat to the public health or welfare. In addition, the provisions of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) promote a coordinated Federal, State and local response to mitigate situations at hazardous waste sites which pose a potential threat to public health. The Trowbridge Estates Mercury Site presented an imminent hazard to public health which provided a legal basis for Federal response activities. The provisions of the National Contingency Plan were implemented by the Environmental Protection Agency, Region III, Philadelphia.

Special thanks are extended to the agencies and groups who participated in this Federal Removal Activity. A prompt evaluation of the situation enabled a timely and efficient mitigation of this threat to human health.

Garrett H. Arai
On-Scene Coordinator
U.S. EPA, Region III
Philadelphia, Pennsylvania

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INTRODUCTION

A. Nature of the Site/Initial Situation

On or about June 11, 1987, the Norristown Regional Office of the Pennsylvania Department of Environmental Resources (PADER) received a complaint from Gregory and Kira Zhivalyuk regarding what appeared to be elemental mercury in their back yard at 701 Trowbridge Estates in Bucks County, Pennsylvania. A representative of PADER Bureau of Waste Management (Mike Pennella) and the Bucks County Health Department investigated the site on June 15, 1987 and obtained a large quantity of a substance from the ground surface which was visually identified by the PADER chemist as being elemental mercury. The PADER Regional Office contacted the PADER Central Office (Doug Lorenzen) in order to refer this case to EPA Region III for further action. EPA was contacted by Mr. Lorenzen on June 16, 1987 and EPA ERS Section Chief Thomas Massey activated the TAT for an assessment.

A preliminary assessment performed by the EPA Technical Assistance Team on June 17, 1987, in accordance with the National Contingency Plan, identified an immediate and significant risk of harm to human health and the environment posed by the presence of mercury in the elemental form in a residential area. The mercury was present on and below the ground surface in close proximity to several residences and a children's play area.

The threat of direct human contact with mercury is substantial as mercury is readily absorbed via the respiratory tract in the form of elemental mercury vapor and dusts, as well as through skin, causing burns. Because the condition at the Trowbridge Estates Mercury Site met the NCP Section 300.65 criteria for a removal action, the OSC utilized Delegation of Authority 14-1-A to activate cleanup activities on June 23, 1987.

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Trowbridge Estates Mercury Site
Federal OSC Report
INTRODUCTION (continued)

B. Site Location

The Trowbridge Estates Mercury Site was located in a condominium development on Route 132, Street Road, in Bucks County, Pennsylvania, on property owned by Mr. and Mrs. Gregory Zhivalyuk. The Zhivalyuks acquired ownership and moved into Trowbridge Estates in December 1986. The previous resident had owned the property since its development in 1975. Aerial photographs revealed this area to be undeveloped farmland prior to the construction of the condominiums.

Site sketches and location maps are located in Appendix A of this report.

C. Efforts to Obtain Cleanup by Potential Responsible Parties

Several potential responsible parties (PRPs) were contacted by the OSC and EPA Legal Counsel, the present property owner, former property owner (Scott Canta), and the developer (Gigliotti). Formal verbal notice of liability was given to the present owner, who declined cleanup responsibility.

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ROSTER OF AGENCIES, ORGANIZATIONS AND INDIVIDUALS, Trowbridge Estates Mercury Site, Bucks County, PA

NAMES AND ADDRESSES	CONTACT	DESCRIPTION OF DUTIES
U.S. EPA - Region III Emergency Response Section 841 Chestnut Building Philadelphia, PA 19107 (215) 597-8170	Garrett H. Arai	Federal On-Scene Coordinator; responsible for the overall success and coordination of the project. Field Administrative Assistant
U.S. EPA - Region III 841 Chestnut Building Philadelphia, PA 19107	Joan Henry Harold Yates Ann Cardinal	Office of Public Affairs; coordinated press releases and addressed media and resident concerns.
	Mary Letzkus Kermit Rader	Enforcement Section Chief Office of Regional Counsel; coordinated all legal activities.
(215) 597-9800 Agency for Toxic Substances Disease Registry 841 Chestnut Building Philadelphia, PA 19107 (215) 597-9800	Joyce McCurdy Mark McLanahan	Recommended the extent of removal necessary to meet "clean" criteria.
Pennsylvania Department of Environmental Resources (PADER) Bureau of Solid Waste Management 1875 New Hope Street Norristown, PA 19401 (215) 270-1885	Mike Pennella George Danyliw Chuck Forneck	Field Inspector Supervisor Chemist, Regional Office
Pennsylvania Department of Environmental Resources (PADER) Central Office 1 Ararat Boulevard Harrisburg, PA 17110 (717) 657-4585	Douglas Lorenzen	Provided assistance to the OSC during removal activities and PRP search.
Bucks County Health Department Neshaminy Manor Center Doylestown, PA 18901 (215) 860-1615	Lee Thomas	Assisted PADER in initial assessment of the site.
Upper Southampton Police 939 Trevoose Southampton, PA 18966 (215) 357-8900 (Emergency)	Lt. Dave Shultz Officer Costello Officer Johnson Officer Walter	Provided on-scene coordination of access restriction with the Township personnel.

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ROSTER OF AGENCIES, ORGANIZATIONS AND INDIVIDUALS, Trowbridge Estates Mercury Site, Bucks County, PA

NAMES AND ADDRESSES	CONTACT	DESCRIPTION OF DUTIES
Upper Southampton Fire Department 925 Street Road Southampton, PA 18966 (215) 357-6353 (Firehouse) (215) 357-8900 (Emergency)	Robert Stahl, Jr. Chief	Assisted in providing adequate site security.
Jan Felgoise 175 Bustleton Pike Feasterville, PA 19047 (215) 698-1800	Jan Felgoise, Attorney	Legal representative for Zhivalyuk.
Joe Safidi 655 Second Street Pike, P.O. Box 1035 Southampton, PA 18966 (215) 357-2990	Joe Safidi, Attorney	Legal representative for the Homeowners' Association
Homeowners' Association P.O. Box 2 Southampton, PA 18966 (215) 364-1353	Donna Siegfried, President John Weis, Vice President	Trowbridge Estates Homeowners' Assoc. who helped inform residents regarding site operations.
Gregory and Kira Zhivalyuk 701 Grantham Lane Trowbridge Estates Southampton, PA 18966 (215) 364-0258 (home)	Gregory Zhivalyuk Kira Zhivalyuk	Homeowners
Roy F. WESTON, Inc., SPER Division 53 Maddonfield Road, Suite 306 Cherry Hill, NJ 08002 (609) 482-0222	Patricia Donegan Kevin Scott Kevin Davis	Provided technical assistance to the OSC during response activities.
O.H. Materials, Inc. 16406 Rt. 224 East Findlay, OH 45940 (800) 537-9540	Bill Buchan	ERCS prime contractor
The Guardian Company 12800 Porter Road Beart, DE 19701 (302) 834-1000 (302) 740-1454 (car phone)	Fred Parker, Response Manager	ERCS subcontractor provided on-scene removal service.

ROSTER OF AGENCIES, ORGANIZATIONS AND INDIVIDUALS, Trowbridge Estates Mercury Site, Bucks County, PA

NAMES AND ADDRESSES	CONTACT	DESCRIPTION OF DUTIES
S & J Trucking P.O. Box 91 Woodstown, NJ 08098 (609)	Dan Donnel, Driver	Transporter of hazardous wastes to Emelle, AL for disposal.
Wastex Labs 28 S. Hanover Street Pottstown, PA 19464 (215) 327-0880	Michelle Diener	ERCS subcontractor provided analytical services on soil samples.
Gigliotti Construction One Summit Square Rt. 413 and Doublewoods Road Langhorne, PA 19047 (215) 860-8700		Builder of Trowbridge Estates.

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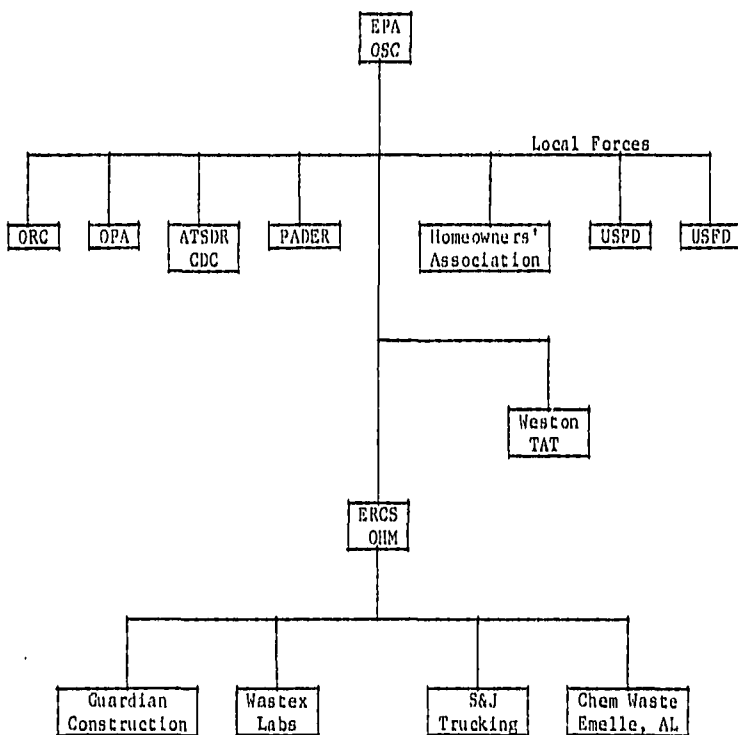
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Trowbridge Estates Mercury Site

Federal OSC Report

ROSTER OF AGENCIES, ORGANIZATIONS AND INDIVIDUALS (continued)

A. Organization of the Response



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Trowbridge Estates Mercury Site

Federal OSC Report

ROSTER OF AGENCIES, ORGANIZATIONS AND INDIVIDUALS (continued)

B. Glossary of Abbreviations

<u>Abbreviation</u>	<u>Definition</u>
ATSDR CDC	Agency for Toxic Substances and Disease Registry, Centers for Disease Control
EPA OSC	U.S. EPA On-Scene Coordinator
ERCS OHM	ERCS Prime Contractor, O.H. Materials, Inc.
Homeowners' Association	Trowbridge Homeowners' Association
OPA	U.S. EPA Office of Public Affairs
ORC	U.S. EPA Office of Regional Counsel
PADER	Pennsylvania Department of Environmental Resources
USFD	Upper Southampton Fire Department
USPD	Upper Southampton Police Department
Weston TAT	Roy F. Weston, Inc. Technical Assistance Team

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NARRATIVE OF EVENTS

On or about June 11, 1987, the Norristown Regional Office of the Pennsylvania Department of Environmental Resources (PADER) received a complaint from Gregory and Kira Zhivalyuk regarding what appeared to be elemental mercury in their back yard. A representative of the PADER Bureau of Waste Management and the Bucks County Health Department investigated the site on June 15, 1987 and obtained a large quantity of the substance which was visually identified by the PADER chemist as being elemental mercury. The PADER Regional Office contacted the PADER Central Office (Doug Lorenzen) in order to refer this case to EPA Region III for further action. EPA was contacted by Mr. Lorenzen on June 16, 1987 and Tom Massey activated the Technical Assistance Team (TAT) for an assessment that date.

The property owners, Mr. and Mrs. Zhivalyuk, purchased the property in December 1986. The previous owner was Mr. Scott Cantor, who purchased the property from the original owners Veree-Welsh Properties, which owned the site at the time of its development into a condominium in 1975. Aerial photographs of the area prior to this time (1965) show only undeveloped farmland.

On June 17, 1987, TAT performed a preliminary site inspection with PADER at the Zhivalyuk residence at 701 Grantham Court, Southampton, Pennsylvania. The TATs visually observed what appeared to be balls of elemental mercury on the ground surface in seemingly isolated portions of the yard both on and near the Zhivalyuk property. The yard (approximately 20 feet by 20 feet) and surrounding property are well kept and show little or no signs of stressed vegetation in the location of the mercury.

The TAT obtained two samples from the area. Sample #1 was taken from an area just beyond the Zhivalyuk property and contained nothing but elemental mercury, as verified by the TAT Regional Safety Officer and QA Officer on site. PADER stated this property belonged to Veree-Welsh Properties. Sample #2 was obtained from the soil underneath the sod (which had been recently replaced) and contained hundreds of visible mercury balls. The mercury rolled out of the ground and onto the sampling scoop when pressure was applied to the ground surface. Photodocumentation was obtained of the sampling areas, yard, and children's playhouse in proximity to the mercury.

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Trowbridge Estates Mercury Site
Federal OSC Report
NARRATIVE OF EVENTS (continued)

Ambient air readings with the mercury vapor analyzer revealed concentrations of 0.5 mg/cu.m approximately one foot above sampling point #1 (the lower limit of the TLV). No other significant readings were obtained either in ambient air or in the Zhivalyuk residence.

On June 24, 1987, a removal action was initiated at this site by OSC Garrett Aral utilizing the ERCS contractor O.H. Materials, Inc. Soil was excavated based on visual observation and lab results indicating mercury contamination. Soil was excavated to a depth of approximately 8 inches and additional samples were collected by TAT from the excavated areas to determine if the contamination had been removed. Analytical results indicated that mercury contamination still existed in these areas. The OSC contacted ATSDR and requested assistance in dealing with this problem. ATSDR's recommendation was to excavate to a depth of 12 inches and then backfill the area with clean fill dirt.

The TAT continued to research methods by which the area had become contaminated and all sample results from this area were given to EPA Enforcement.

By June 26, 1987, ten drums of contaminated soil had been excavated from the Zhivalyuk's back yard. The drums were removed from the site and transported to a Chem Waste facility in Emelle, Alabama for disposal.

On June 27, 1987, the area had been backfilled and reseeded thereby eliminating the threat to human health and the environment.

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Trowbridge Estates Mercury Site
Federal OSC Report

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RESOURCES COMMITTED

A. Initial Funding Request

On June 23, 1987, Special Bulletin A was submitted regarding the use of and need for an emergency activation of \$50K under the OSC's Delegation of Authority 14-1-A (5/1/85). A copy of Special Bulletin A is included as Appendix B of this report.

B. Chronological Expenditure Log

<u>Date</u>	<u>EXTRAMURAL</u>			<u>INTRAMURAL</u>	<u>Total Costs to Date</u>	<u>Funding Ceiling</u>
	<u>ERCS</u>	<u>TAT</u>	<u>Other</u>	<u>EPA</u>		
6/23/87	\$	\$ 650	\$2,000	\$123	\$ 2,773	\$50,000
6/24/87	2,466	1,085		180	6,504	50,000
6/25/87	2,081	448		94	9,127	50,000
6/26/87	1,666	528		94	11,415	50,000
6/27/87	1,789	325			13,529	50,000

C. Total Cost Summary (Estimated)

1. Extramural

ERCS

Personnel/Labor	\$ 6,176
Equipment	1,265
Materials	511
Subcontractors	50
a) Analytical	
b) Transportation	
c) Disposal	
d) Miscellaneous	2,000

TAT 3,036

Extramural Subtotal \$13,038

2. Intramural

EPA \$ 491

ESTIMATED TOTAL PROJECT COST \$13,529

PROJECT CEILING: \$50,000

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Trowbridge Estates Mercury Site
Federal OSC Report

EFFECTIVENESS OF THE REMOVAL

A. Activities of Various Agencies

1. Potential Responsible Parties

The OSC informed the present owners of the property of their responsibility and they declined to accept responsibility for the cleanup. As a result, the OSC utilized his Delegation of Authority to activate CERCLA funds for the removal.

2. State and Local Forces

The Pennsylvania Department of Environmental Resources (PADER), Division of Hazardous Waste Management issued an EPA Generator ID Number which enabled materials to be legally transported from the site for disposal. They also aided in the initial assessment of the site and assisted in the identification of the contaminant present.

The Upper Southampton Police Department provided snow fencing and barricades for maintaining site security.

The Upper Southampton Fire Department provided information on previous property owners.

3. Federal Agencies and Special Forces

The On-Scene Coordinator (OSC) was responsible for the overall success of the cleanup, which included contractor task direction and coordination of all technical aspects of mitigating the threat to human health and the environment.

The EPA Office of Regional Counsel provided advice and guidance to the OSC regarding legal aspects of the removal.

The EPA Office of Public Affairs was responsible for informing residents of the situation by going from door to door.

ATSDR/CDC provided information on "how clean is clean" and recommended the extent of removal necessary to meet the clean criteria.

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Trowbridge Estates Mercury Site
Federal OSC Report
EFFECTIVENESS OF THE REMOVAL (continued)

A. Activities of Various Agencies (continued)

4. Contractors

The Spill Prevention and Emergency Response Division of Roy F. Weston, Inc. provided personnel from the Technical Assistance Team (TAT). TAT provided technical support to the OSC through extent-of-contamination sampling, photo documentation of site activities, air monitoring, contractor and site safety monitoring, and written site activities documentation.

O.H. Materials, Inc. of Findlay, Ohio (OHM) served as the ERCS prime contractor and was responsible for providing the necessary materials, equipment and personnel required to complete the cleanup. OHM coordinated all subcontractor activities including: a) Removal activities performed by Guardian; b) transportation by S&J Trucking; c) disposal at Chem Waste; and d) laboratory analysis by Wastex Labs.

B. Disposal Methods and Quantities Removed

In determining disposal alternatives, verbal results from sample analyses were utilized to select the most environmentally safe and cost-effective options.

All excavated, contaminated soil was drummed and sent to Chem Waste Management in Emelle, Alabama for final disposal.

A total of 10 drums (500 pounds) of D009 waste was removed from the site (9 drums of soil and one drum of protective clothing). All drums were transported by S&J Trucking via Manifest #0001A, a uniform manifest from the Office of Management and Budget (OMB). Because this manifest format had expired on July 31, 1986, the OSC elected to transfer the information onto a disposer state manifest after the drums were at the S&J Trucking terminal during in-transit storage.

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Trowbridge Estates Mercury Site Federal OSC Report

CHRONOLOGY OF EVENTS

The following is a brief summary of major site activities during the Trowbridge Estates Mercury Removal Action. A more detailed account of these events is located in Appendix I (POLREPS) of this report.

- June 16, 1987 PADER Central Office notified EPA Region III that they had found what appeared to be elemental mercury on the Zhivalyuk property.
- June 17, 1987 EPA Technical Assistance Team (TAT) performed a site inspection with PADER, as directed by the OSC, and found elemental mercury in relatively large quantities throughout the ground surface.
- June 23, 1987 OSC Arai and TAT visited the site for further inspection immediately after receiving communication from PADER confirming and supporting the need for emergency response actions.

The OSC notified the following EPA personnel via telephone in regard to developments and future plans at this site: Mary Letzkus (Enforcement Section Chief), Charles Kleeman (Deputy Section Chief), Kermit Rader (Legal Counsel), Ann Cardinal (Office of Public Affairs), and Joyce McCurdy (CDC).

The OSC notified the following potential responsible parties (PRPs) and PRP representatives regarding site developments: Property owners (Gregory and Kira Zhivalyuk, property developer (Gigliotti Construction), former property owner (Scott Cantor) and the Homeowners' Association.

PADER representative Mike Pennella informed the OSC and TAT that PADER chemist verified the presence of mercury in site samples.

OSC met with property owners (Zhivalyuks) and explained their potential responsible party (PRP) status as well as planned future site activities.

OSC activated ERCS to provide site security for this date and arrange to have a crew on site in the morning.

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Trowbridge Estates Mercury Site
Federal OSC Report
CHRONOLOGY OF EVENTS (continued)

June 23, 1987 OSC contacted Upper Southampton Police Department informing them of planned activities. Police and Fire Department representatives were on site to offer equipment and personnel to erect barriers, snow fence and bannerguard.

OSC was informed that the mercury vapor analyzer, recommended by TAT for use in on-site monitoring during removal activities, was not available until June 25, 1987. ATSDR/CDC McCurdy and Gray approved the use of level C protection with cartridges specific for mercury vapors.

June 24, 1987 ERCS (Guardian) excavated four drums of mercury-contaminated soil by hand.

TAT collected sixteen (16) soil samples this date. Samples were picked up by Wastex Lab and were to be analyzed for total mercury.

OSC contacted EPA/OPA and Enforcement with an update of site status.

EPA/OPA (Hal Yates) was on scene and contacted/updated residents of the situation.

PADER (Mike Pennella and George Danyliw) on scene to assist with site activities.

OSC briefed the attorney for Trowbridge Estates.

ERCS finalized disposal arrangements with Chem Waste Management in Emelle, Alabama.

OSC contacted Gigliotti Construction to obtain information regarding the fill dirt used for the development.

June 25, 1987 OSC notified neighborhood residents of site activities.

TAT and ERCS conducted a comprehensive investigation of the Zhivalyuk property on hands and knees in search of elemental mercury.

TAT performed air monitoring with mercury vapor analyzer in the excavated area, which revealed no readings above the low-range TLV.

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Trowbridge Estates Mercury Site
Federal OSC Report
CHRONOLOGY OF EVENTS (continued)

June 25, 1987 ERCS response manager delivered samples, taken by TAT of clean areas, to lab for quick turnaround.

June 26, 1987 OSC received verbal results from lab indicating that mercury contamination remained in isolated areas.

OSC contacted ATSDR (Atlanta) for advice and guidance on continued actions. ATSDR recommended excavation to 12 inches and then cover with clean fill and sod.

OSC instructed TAT to take soil cores on the Zhivalyuk property for visual inspection and also to visually inspect the neighborhood.

PADER representative (Danyiliw, Norristown Office) was on site to express concern regarding future use of the property which may require excavation below the 12-inch level. OSC agreed to resample areas cleaned this date prior to backfilling.

Transporter for drums (S&J Trucking) on site to pick up ten drums of D009 waste to be taken to Emelle, AL for final disposal.

June 27, 1987 ERCS response manager contacted TATM Donegan with lab results. Samples indicated areas cleaned successfully. OSC instructed crew to backfill and resod to complete removal activities.

ERCS crew backfilled and sodded all excavated areas after bailing out water from morning's rainfall.

Security fencing removed and Township Police contacted to pick up their materials.

TAT informed resident of 700 Trowbridge Avenue that the sample obtained from his property was not contaminated with mercury.

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Trowbridge Estates Mercury Site
Federal OSC Report

PROBLEMS ENCOUNTERED AND RECOMMENDATIONS

The combined efforts of the various participating organizations/agencies enabled the Removal Action at the Trowbridge Estates Mercury Site to proceed in an efficient and timely manner. As a result, no significant problems were encountered.

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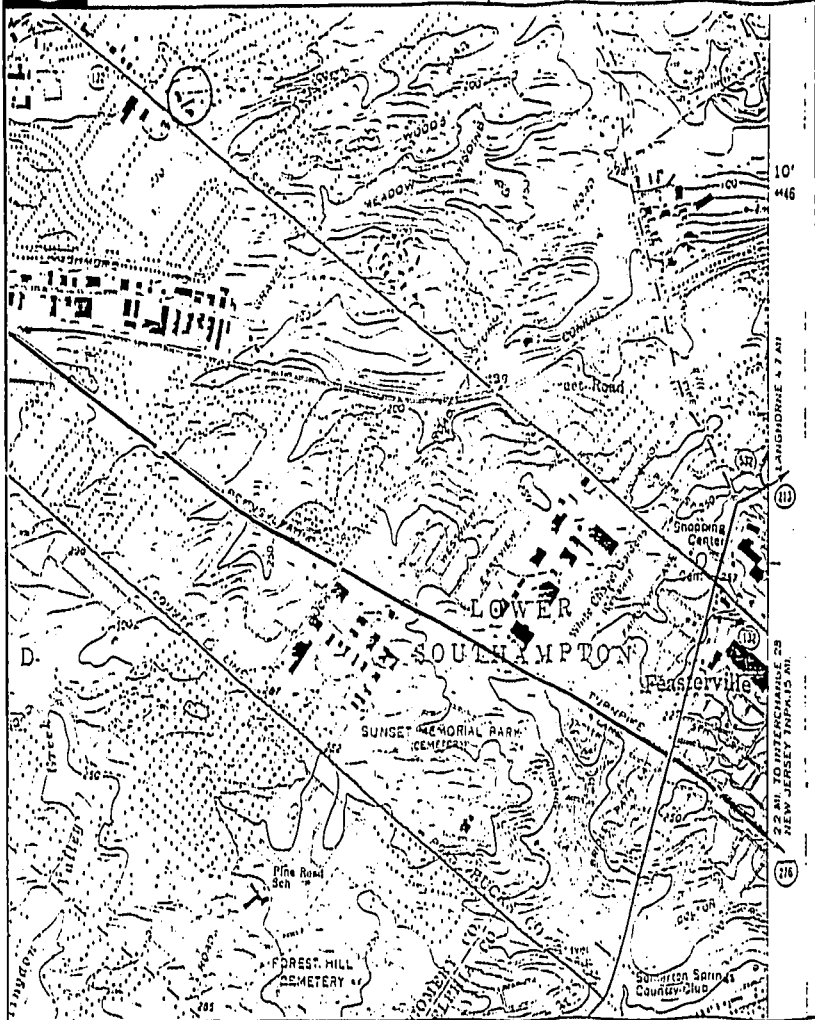
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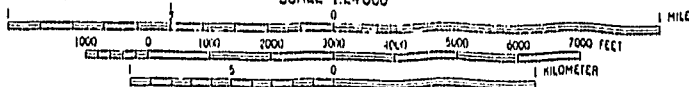
WESTON-SPER

TDD Number:

PCS Number: 1275



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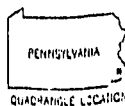


CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC HEIGHT DATUM OF 1929

GRID AND 1983 MAGNETIC NORTH
CLINATION AT CENTER OF SHEET

TROWBRIDGE ESTATES

MERCURY SITE



HATBORO, PA.

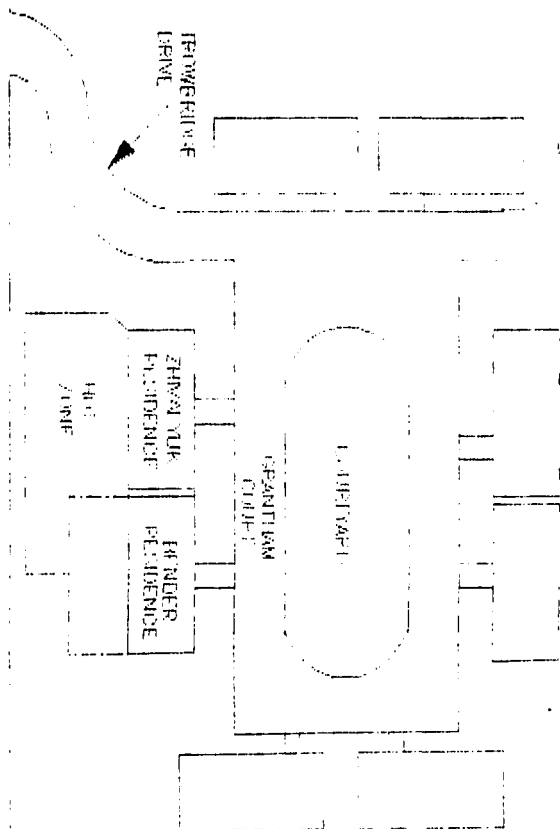
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NORTH

THE AMERICAN LEGATION
SOUTHAMPTON, LONDON, ENGLAND
JUNE 24, 1971
LATE SKETCH



CELL PHOTO (JL 171)

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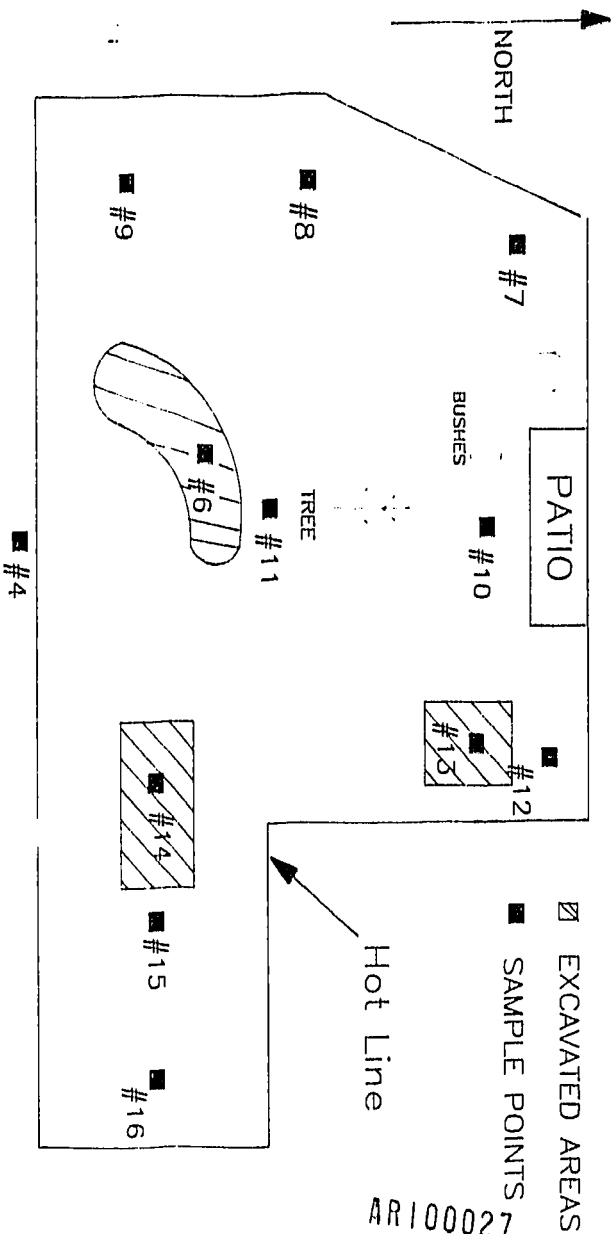
DRAWING NOT TO SCALE

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TROWBRIDGE ESTATES MERCURY SITE ENLARGEMENT OF HOT ZONE/SAMPLES TAKEN JUNE 24, 1987

#1
 FRONT LAWN
 WEST SIDE OF HOUSE
 #3
 COURTYARD

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STREET ROAD (RT 132)

DRAWING NOT TO SCALE

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SPECIAL BULLETIN A
Trowbridge Estates Mercury Site
Southampton, Bucks County, PA

Date: June 23, 1987

FROM: Garrett Arai, On Scene Coordinator

TO: Stephen Wassersug, Director
Hazardous Waste Management Division

THRU: Thomas Voltaggio, Chief
Superfund Branch

THRU: Thomas Massey, Chief
Emergency Response Section

I. INTRODUCTION

A preliminary assessment performed by the EPA Technical Assistance Team in accordance with the NCP has identified an immediate and significant risk of harm to human health and the environment posed by the presence of mercury in the elemental form in a residential area. The mercury is present on and below the ground surface in close proximity to several residences and children's play areas.

Section 104 of CERCLA calls for the initiation of immediate removal action where there is a threat of a release of a hazardous substance which may present an imminent and substantial danger to public health or welfare.

The Delegation of Authority 14-1 A (5/1/85) authorizes the OSC to approve CERCLA removals with a total cost of less than \$50,000, therefore the OSC has approved the use of CERCLA funds at this site for control of site access, sampling, and removal of contaminated material as the funding allows.

II. BACKGROUND

The Trowbridge Estates Mercury Site is located in a condominium development in Bucks County, PA, on property owned by Mr. and Mrs. Gregory Zhivalyuk. The Zhivalyuks acquired ownership and moved in in December, 1986; the previous resident had owned the property since its development in 1975. Aerial photographs reveal this area to be undeveloped farmland prior to the condominium development.

On or about June 11, 1987, the PADER Norristown office received a report from the Zhivalyuks regarding what appeared to be elemental mercury in their immediate backyard, which is approx 20' x 20' in size. The PADER Regional office investigated the site along with the Bucks County Health Department, and collected a sample of the material. After visual examination of this material by the DER chemist it was determined to be mercury. The

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PADER Central office requested EPA assistance on June 16, 1987, and the TAT performed a site assessment on June 17, 1987. TAT collected two samples, both of which contained elemental mercury as visually determined by the TAT Regional Safety Officer. Samples taken previously by the PADER had been visually inspected and determined by the regional chemist to contain elemental mercury as well.

On June 23, 1987, the EPA, TAT and PADER returned to the site and found additional mercury present on the ground surface in close proximity to the residential living quarters and childrens play area. The OSC activated emergency funding that date to provide site security and immediate removal of contaminated areas.

III. THREAT

The threat of direct human contact with mercury is substantial. Mercury is readily absorbed via the respiratory tract in the form of elemental mercury vapor and dusts, and also through absorption through intact skin, causing burns also. Acute mercury poisoning results in death within days; chronic results in nervous system and kidney damage. In its present form and location, mercury is easily accessible to both children and adults in the area; the residents have made previous attempts to remove the mercury from the yard themselves without personal protection.

IV. SCOPE OF WORK

The scope of work proposed for implementation with the emergency \$50,000 appropriation will include restricting access with posting, banner guard, and onsite security personnel; excavating and transporting contaminated soil to an approved disposal facility; performing extent of contamination sampling and sampling cleaned areas. The proposed budget is as follows:

ERCS-\$30K
EPA-\$10K
TAT-\$10K

VI. OSC ACTION

Because the conditions at the Trowbridge Estates Mercury Site meet the NCP Section 300.65 for an immediate removal, I have approved this immediate removal action. The estimated total project cost is less than \$50,000.

Garrett Arai, OSC
USEPA Region III
Philadelphia, PA

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SITE/SAFETY PROTOCOL

Troubridge Estates Property Site
Belle County, PA

GENERAL

This protocol addresses the safety procedures that will be followed by any and all personnel visiting the site or involved in the CERCLA removal activity at Troubridge Estates Property Site. All personnel entering the site shall read and sign this safety plan. The protocol will remain in effect until the OSC certifies that the activity is terminated. It does not supersede any Federal OSHA or State or local regulations but is in addition to them. In the event of a conflict between this protocol and a regulation, the more stringent of the two will be in force.

Since data available at the present time does not allow a complete characterization of the balled waste on the site, levels of protection for personnel will be set in accordance with the hazard of the job function and location on-site as indicated on the attached diagram.

Respiratory Protection Program

All contractor and governmental personnel involved in on-site activities shall have a written respiratory protection program and prove that they are physically fit to wear a respirator. All personnel wearing air-purifying respirators on-site are required to be fit tested, while those wearing pressure-demand self-contained breathing apparatus or air-line apparatus, must be properly trained and experienced in their use. All respiratory protection equipment is to be properly decontaminated at the end of each workday.

Persons having beards or facial hair must not wear a respirator.

Training and Medical Monitoring Program

Personnel will have either formal training or on-the-job training for those tasks they are assigned to perform on the active site. All unfamiliar activities will be rehearsed beforehand.

All contractor and governmental personnel who are exposed to hazardous levels of chemicals shall prove that they are enrolled in a medical monitoring program.

AR100030

DRAFT

①

Site Safety Protocol

Townbridge Estates Mercury Site

Page 2

General Safety Rules and Equipment

- a. There will be no eating, drinking or smoking in the Exclusion Area or hot side of the Contamination Reduction Area.
- b. All personnel must pass through the Contamination Reduction Area to enter the Exclusion Area.
- c. An emergency eye wash will be on the hot side of the Contamination Reduction Area.
- d. As a minimum, an emergency deluge shower/spray can is to be located on the clean side of the Contamination Reduction Area.
- e. At the end of the work, all personnel working in the Exclusion Area shall take a hygienic shower.
- f. All supplied breathing air shall be certified as Grade D or better.
- g. Where practical, all tools/equipment will be spark proof, explosion resistant and/or bonded and grounded.
- h. Fire extinguishers will be on-site for equipment or personnel fires only.
- i. A first-aid kit will be on-scene at all times during operational hours. An oxygen inhalator respirator will be available. The location of these items on-site will be posted.
- j. Persons having beards or facial hair must not wear respirators.
- k. No work will be performed in the exclusion area during hours of darkness as determined by the site safety officer.

Morning Safety Meeting

A morning safety meeting will be conducted each day for all site personnel who sign a daily attendance sheet. The safety procedures, evacuation procedures, and escape procedures, as well as the day's planned operations, should be discussed.

AR100031

DRAFT

Site Safety Protocol

Therapeutic Systems Company Site

Page 3

CONTROL AT THE SITE

Access to the site will be restricted by a site security officer and banner guard installed during the immediate removal phase at this site and exit from the site shall be through the gate in the Contamination Reduction Area except in a life-threatening emergency.

All persons entering the site shall sign in and out at the OSC command post or with the site security officer.

DESIGNATION OF WORK AREAS AT THE SITE

The entire site will be divided into three areas: (1) Exclusion Area which known to be or have a potential for becoming contaminated; (2) the Contamination Reduction Area where decontamination of personnel and equipment exiting the Exclusion Area is performed; (3) the Support Area which is not contaminated.

The Exclusion Area (EA)

At the Therapeutic Systems Company Site, the Exclusion Area shall initially include all areas inside the banner guard.

The Contamination Reduction Area (CRA)

At the Therapeutic Systems Company Site, the Contamination Reduction Area will be located immediately outside the Exclusion area and will be delineated by rope off area.

The Support Area (SA)

Exclusion Area and Contamination Area.

Changes in Designation of Work Areas

As work progresses on-site, the OSC may determine that an area previously designated as EA is no longer classified in that manner. It is not intended, however, to change the designation of the CRA since this may involve the movement of the decontamination facilities and added expense.

SAFETY PROCEDURES AND LEVELS OF PROTECTION

Exclusion Area

1. All personnel shall enter and exit the Exclusion Area through the Contamination Reduction Area.
2. Emergency escape routes from the Exclusion Area will be established and reviewed as appropriate at each morning safety meeting.

AR100032

DRAFT

Site Safety Protocol

Troubridge Estates Mercury Site

Page 4

SAFETY PROCEDURES AND LEVELS OF PROTECTION (continued)

Exclusion Area

3. All personnel in the Exclusion Area shall use the protective equipment designated for their job function but in no case shall less than LEVEL C be used.
4. Personnel performing the following job functions in the Exclusion Area will utilize the designated level of protection equipment.

Contamination Reduction Area

1. Personnel and equipment decontamination will be performed in Level C.
2. All personnel entering the CRA will utilize a minimum of Level C protection.
3. All personnel entering the CRA as decontaminants which will be performed in Level C.
4. All equipment entering the CRA must be decontaminated prior to leaving the CRA.

Support Area

1. No contaminated equipment or personnel may enter the Support Area.
2. Except in the case of a release of a Toxic vapor, Level D will be appropriate for all personnel in the Support Area.

Prime Contractor

- a. Barrel handling, including opening, sampling, pumping, moving, emptying, or any direct or indirect disturbance of a full-barrel will be performed in Level B. This applies to anyone involved, including equipment operators.
- b. Excavation operations will be performed in Level C.
- c. Soil removal operations will be performed in Level C.
- d. Maintenance of filter fencing will be done in Level C unless photoionization detector readings are below 5 ppm in which case Level B will be used.

AR100033

DRAFT

Site Safety Protocol

Troubridge Estates Mercury Site

Page 5

DECONTAMINATION PROTOCOL

All equipment and personnel entering the site must be thoroughly decontaminated prior to leaving the site. Since there are various protocol and equipment available for this purpose, the OSC will determine if the proposed decontamination techniques are applicable. Such determinations will be made on a day-to-day basis as on-site operations dictate.

ON-SITE AIR MONITORING

Additional air sampling will be dependent on the data obtained from onsite. Photoionization Detector and/or Organic Vapor Analyzer. Additional air monitoring will be performed as conditions warrant. This monitoring will be designed and performed by the OSC or his technical staff.

AR100034

DRAFT

Site Safety Protocol

Comanche State Prison

Page 6

EMERGENCY PROCEDURES

In the event of a medical or other emergency, the OSC or his designee will notify the appropriate authority. The following list of phone numbers will be posted prominently at each telephone on-site:

1. Fire 911
2. Ambulance 911
3. Police 361 330 1111
4. Federal Government 572 9844 EPA Region 8, Austin, TX
5. State Government 214 241-1555 Mr. Penella
6. County/City Government 214 811 1313
7. EPA Environmental Response Team 1/1A
8. Hospitals Franklin Hospital
Baylor Park

AR100035

DRAFT

SITE SAFETY PROTOCOL Attachment A

WEATHER AND HEAT STRESS

Adverse weather conditions are important considerations in planning and conducting site operations. Hot or cold weather can cause physical discomfort, loss of efficiency and personal injury. Of particular importance is heat stress, resulting when protective clothing decreases natural body ventilation. The following recommendations will help reduce heat stress:

1. Provide plenty of liquids. To replace body fluids (water and electrolytes) lost due to sweating.
2. Install mobile showers and/or hose-down facilities to reduce body temperature and cool protective clothing.
3. In extremely hot weather, conduct nonemergency response operations in the early morning or evening.
4. Ensure that adequate shelter is available to protect personnel against heat, cold, rain, snow, etc., which can decrease physical efficiency and increase the probability of accidents.
5. In hot weather, rotate shifts of workers wearing impervious clothing.

Heat Stress Monitoring

Due to the time of year, a Heat Stress Monitoring Program may be needed during working hours. Personnel would be subject to the following monitoring program:

For monitoring the body's recuperative ability to excess heat, one or more of the following techniques will be used as a screening mechanism. Monitoring of personnel wearing impervious clothing should commence when the ambient temperatures increase or as slow recovery rates are indicated. When temperatures exceed 83°F, workers should be monitored for heat stress after every work period.

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SITE SAFETY PROTOCOL

Attachment A

Page 2

HEAT STRESS MONITORING (continued)

1. Heart rate (HR) should be measured by the radial pulse for 30 seconds as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 110 beats per minute. If the HR is higher, the next work period should be shortened by 10 minutes (or 33%), while the length of the rest period stay the same. However, if the OT exceeds 99.7°F at the beginning of the next period, the following work cycle should be further shortened by 33%. OT should be measured again at the end of the rest period to make sure that it has dropped below 99°F.
2. Body water loss (BWL) due to sweating should be measured by weighing the worker in the morning and in the evening. The clothing work should be similar at both weighings; preferably the worker should be nude. The scale should be accurate to plus or minus 1/4 lb. BWL should be instructed to increase his daily intake of fluids by the weight lost. Ideally, body fluids should be maintained at a constant level during the work day. This requires replacement of salt lost in heat as well.
3. Blood pressure before and after each work period will be monitored.
4. Good hygienic standards must be maintained by frequent changes of clothing and daily showering. Clothing should be permitted to dry during rest periods. Persons who notice skin problems should immediately consult medical personnel.

Effects of Heat Stress

If the body's physiological progresses fail to maintain a normal body temperature because of excessive heat, a number of physical reactions can occur ranging from mild (such as fatigue, irritability, anxiety and decreased concentration, dexterity or movement) to fatal. Standard reference books should be consulted for specific treatment.

Heat-related problems are:

- Heat Rash: Caused by continuous exposure to heat and humid air and aggravated by chafing clothes. Decreases ability to tolerate heat as well as being a nuisance.
- Heat Cramps: Caused by profuse perspiration with inadequate fluid intake and chemical replacement (especially sodium). Signs: Muscle spasm and pain in the extremities and abdomen.

AR 100037

DRAFT

SITE SAFETY PROTOCOL
Attachment "A"

San Diego County Sheriff's Office
Page 3

EFFECTS OF HEAT STRESS (continued)

- Heat Exhaustion: Caused by increased stress on various organs to meet increased demands to cool the body. Signs: Shallow breathing; pale, cool, moist skin; profuse sweating; dizziness and lassitude.
- Heat Stroke: The most severe form of heat stress. Body must be cooled immediately to prevent severe injury and/or death. Signs and symptoms are: Red, hot, dry skin; no perspiration; nausea; dizziness and confusion; strong, rapid pulse, coma.

Any personnel that feels he is displaying any effects of heat stress that may not be known to the medical monitoring personnel, will report these immediately.

AR100038



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HEALTH AND SAFETY PLAN
APPROVAL/SIGN OFF FORMAT

I have read, understood, and agreed with the information set forth in this Health and Safety Plan (and attachments) and discussed in the Personnel Health and Safety briefing.

<u>Charles S. Smith</u> Name	<u>Charles S. Smith</u> Signature	<u>27 June 87</u> Date
<u>RONALD E. LUMLEY</u> Name	<u>Ronald E. Lumley</u> Signature	<u>6-24-87</u> Date
<u>FRED PARKER</u> Name	<u>Fred Parker</u> Signature	<u>6-24-87</u> Date
<u>Garrett Ann</u> Name	<u>Garrett Ann</u> Signature	<u>6-24-87</u> Date
<u>Pat Donagan</u> Name	<u>Pat Donagan</u> Signature	<u>6-24-87</u> Date
<u>Thomas (Gennella) PADER</u> Name	<u>Thomas (Gennella) PADER</u> Signature	<u>6-24-87</u> Date
<u>KEVIN SCOTT</u> Site Safety Co-ordinator	<u>Kevin Scott</u> Signature	<u>6/24</u> Date

Director, Corporate
Health and Safety

Signature

Date

Project Manager

Signature

Date

Project Director/
Department Manager

Signature

Date

X Personnel Health and Safety Briefing Conducted By:

KEVIN J DAVIS
Name

Kevin J Davis
Signature

24 June 87
Date

ART00039

DRAFT

Bucks County Courier Times



Photo by Joe Dixon

Members of the EPA's crew take soil samples at the house.

Toxin found in back yard is removed

By Carole Fleck
Courier Times Staff Writer

An Upper Southampton town house sat abandoned Wednesday as uniformed workers from the federal Environmental Protection Agency sifted through soil in the back yard and removed a small quantity of mercury.

EPA spokesman Harold Yates said a team of workers removed four "patches" of soil containing tiny beads of the toxic substance. Yates likened the quantity of mercury to 5 percent of the back yard.

The homeowners contacted the county Health Department and the state Department of Environmental Resources on June 11 after noticing what they suspected to be mercury on their lawn.

Gregory and Kira Zhivalyuk

(Continued on Page 13)

AR100040

DRAFT

THURSDAY, JUNE 25, 1987



Photo by Joe Dixon

Crew member Pat Donegan checks out some of the soil.

Mercury is discovered in home's back yard

(Continued from Page 1)

and their family moved out of the home at 701 Grantham Court, in the quiet, tree-lined Trowbridge town house development, shortly afterward, Yates said. They are staying with relatives until they feel satisfied that the mercury has been removed.

Garrett Arai, an on-site coordinator for the EPA, said a technical assistance team wearing white jumpsuits, orange boots, gloves and masks removed mercury from isolated areas. They filled three drums with soil, which will be sent to Alabama for testing, and visually surveyed the surrounding properties for mercury. He said none was found.

Arai said the DER contacted the EPA to assess the contaminated property. He said the technical assistance team surveyed the site last Wednesday and determined there was no danger because no mercury vapors were found in the house.

"I've never heard of a mercury problem in or outside anybody's house," Arai said. "This is a first for me."

fumes must be ingested or inhaled before they pose a health risk. He said the maximum contaminant level of mercury allowed in drinking water is 0.002 milligrams per liter, equal to 0.002 pounds of mercury per 1 million pounds of water.

He said mercury affects the nervous system and ultimately can cause loss of vision and hearing, intellectual deterioration and brain damage.

Yates said the DER removed a large quantity of mercury from the back yard on June 15, but did not say how much.

Yates said he was baffled as to how the mercury got into the back yard of the Zhivalyukhs, who moved into the corner town house in January.

Yates said he contacted the previous owners and immediate neighbors but could not determine the source of the mercury.

The Zhivalyukhs, after noticing damaged vegetation on the lawn, put down sod and turf in the back yard. But the mercury, which Yates suspects was present in the soil, "worked its way back to the surface" despite its heavy metal density.

Yates said the EPA will investi-

AR100041

**DRAFT**

Originator _____

PHONE CONVERSATION RECORD

Conversation with:

Name Paul BakerCompany Western

Address _____

Phone _____

Subject Therapeutic ResultsDate 6, 25, 87Time 11:05 (AM/PM)☐ Originator Placed Call☐ Originator Received Call

W.O. NO. _____

Notes: 1-14 sample 11/11202 - 743 - 1454 - 0111
None.1 - 0.0382 - 0.0204/1/88 2.2 - 834-10003 - 0.0224 - 0.0845 - 0.056Background Soil Conc. as per USGS
= .09 Hg ppm* 6 - 14.807 - 0.0388 - 0.0489 - 0.04610 - 0.05411 - 0.076* 12 - 24.00* 13 - ~~600~~ 640.00* 14 - 200.015 - 0.40016 - 0.040☐ File _____☐ Tickle File 1 1☐ Follow-Up By: _____☐ Copy/Route To: _____

Follow-Up-Action: _____

ARI00042

Originator's Initials _____



DRAFT

Originator _____

PHONE CONVERSATION RECORD

Conversation with:

Name Fred ParkerCompany Guardian

Address _____

Phone _____

Subject Hg. Cr +6 resultsDate 6/26/87Time 10:10 AM/PM☐ Originator Placed Call☐ Originator Received CallW.O. NO. 302-834-1000

Notes:

Cr +6 ppm12) < 1.013) < 1.0visible Hg - original14) 1.2visible Hg - " " "

15) _____

16) _____

Hg ppm mg/kg17) 184.00 - resample Area C small area18) 16.00 - resample near grill19) 400.00 - resample from med. size excav. area 'C'20) 1.40 - resample large area

Talked to one of guys familiar w/ Hg - ~~mentioned~~ he said it's probably spread around yard - probably from factory site - dumped.

Probably go 1 more day w/o going \$30K

☐ File _____☐ Tickle File _____ / _____ / _____☐ Follow-Up By: _____☐ Copy/Route To: _____

Follow-Up Action: _____

ARI00043

Originator's Initials _____

FIGURE 4-3
CHAIN OF CUSTODY RECORD

DN 3
Curtis Bldg., 10th & Walnut Sts.
Philadelphia, Pennsylvania 19106

PROJECT NAME		NO OF CONTAINERS		REMARKS	
PROJECT NAME		NO OF CONTAINERS		REMARKS	
Hawthorne Estates Hg St					
K. Beath, P. Doregan					
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R DN3
Curtis Bldg., 6th & Walnut Sts.
Philadelphia, Pennsylvania 19106

DRAFT

3-19719

DRAFT

Pat Dineen
Ray F. Weston
S3 Macomber RJ

Sub 206
Query 1477 WT: 08002

In response to your recent request, we are happy to forward the attached material. We hope it will provide you with the necessary information that you desire.

If we may be of any further service, please feel free to contact this office.



Michael J. Dineen
Pennsylvania Department of Environmental Protection
Bureau of Water Management
1975 New Hope Street
Harrisburg, PA 17101
(717) 720-1549

DATE 07/1/85

ER-WM-36: 1286

AR100047

DRAFT

Subject: Mercury Contamination
Upper Southampton Twp
Bucks Co. Pa.
Tax Parcel #'s 48-25-50
48-25-133

Re: File

From: Michael Pennella
Waste Management Specialist

A complaint investigation concerning the spillage of Mercury was conducted on Tuesday June 16, 1987 at the Trowbridge Estates Condominium Development in Upper Southampton Township, Bucks Co. Pa. At 9:00 AM I met with Mr. Gregory Zhivlyuk, of 701 Grantham Ct., who has lived at the property since January of 1987.

At the site he pointed out four distinct areas where mercury has been found and removed. I collected about 1/2 ounce of pure mercury from the surface of the lawn. Much more is still remaining on the surface. A 500 ml soil sample numbered 2136047 was collected from an area where visible contamination was detected in the soil and sent to the DER Harrisburg lab for Quantification.

Throughout the remainder of the day I contacted other agencies regarding the contamination including the Bucks County Health Department, U.S. EPA, and the Bureau of Waste Management, Division of Emergency and Remedial Response, who I requested Technical Assistance from in this case.

BP100048

DRAFT

Subject: Upper Southampton
Mercury Contamination
Tap Panel #3

Request for Technical Assistance

Thru: George Danyliw
Norristown Waste Management Field
Operations Supervisor

To: Douglas Lorenzon

DER Division of Emergency and Remedial Response

From: Michael Pennella

Waste Management Specialist; Norristown

Investigating a complaint at the Trowbridge Estates
Condominium development, Upper Southampton Twp. Bucks Co. Pa.
I discovered areas where Mercury has been collecting
both in the soil and on the surface of the lawn.
Through this memo I am requesting Technical Assistance
from your Division so that the cause and source
of this material can be ~~possibly~~ ^{thoroughly} examined.

AR100050

DRAFT

To: ERD/DERR (EPASS11)
To: T. MASSEY (EPA9374)
From: T. MASSEY (EPA9374) Delivered: Wed 24-June-87 6:50 EDT Sys 163 (1)
Subject: MERCURY SITE
Mail Id: IPM-163-870624-061640638

POLREP #1

Trowbridge Estates Mercury Site
Southampton, Bucks County, PA
Attn: T. Massey and T. Fields

I. Situation (2000 hours, 6/23/87)

A. EPA on site this date to investigate reports from PADER and TAT concerning mercury contamination on a residential property in Trowbridge Estates, Bucks County, PA. OSC Arai, TAT and PADER on site to review areas sampled; elemental mercury visible on ground surface in close proximity to residential living quarters and children's play area. OSC activates \$50K emergency funding this date for emergency removal, site security, and sampling, based on site assessment and PADER/CDC recommendation. Properties affected belong to the Zhivalyuk family and open ground owned by the Trowbridge Estates Homeowners Assoc.

B. Personnel on Scene:

EPA-1
TAT-2
PADER-1
Upper Southampton Police Dept.-4
Upper Southampton Fire Dept.-1
Two. Personnel-2
Property owners

C. Weather: Hot, Humid, high 80's

II. Actions Taken

A. EPA Region III was notified on 6/16/87 at 1329 hours by PADER Central Office of what appeared to be elemental mercury on the Zhivalyuk property. The Zhivalyuks had notified the State Health Dept. of this during the week of June 11, 1987. The EPA Technical Assistance Team (TAT) performed a site inspection 6/17/87 with PADER and found elemental mercury in relatively large quantities throughout the ground surface of the Zhivalyuk property. OSC Arai and TAT arrived on site for further inspection 6/23/87 at 1130 hours, immediately after receiving communication from PADER which confirming and supporting the need for emergency response actions by the Agency.

B. OSC notified the following EPA personnel via phone regarding developments and future plans at this site: Mary Laf Bus, Enforcement Section Chief; Charlie Kleeman, Deputy Section Chief; Kermit Rader, Legal Counsel; Ann Cardinal, OPA representative; Joyce McCurdy, CDC.

C. OSC notified the following PRPs and PRP representatives regarding site developments: Property owners Gregory and Kira Zhivalyuk at 1140 hrs.; Property developer Binlotti Const. at

AR100051

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1217 hrs. (not avail.); Former property owner Scott Cantor at 1218 hrs. (not avail.); Homeowners Assoc. at 1830 hrs. No PRP assumed cleanup responsibility at this time.

D. PADER Mike Pennella on site 1150 hours. Informed OSC and TAT that PADER chemist verified the presence of mercury in site samples after visual observation. PADER rep. on site until 1535 hours.

E. Property owners (Zhivalyuk) on site 1315 hrs. OSC explained situation and future plans for removal. Property owners agreed to removal operations beginning 0800 hours 6/24/87 without their presence.

F. OSC activates ERCS at 1430 hours to provide site security personnel this date and arrange for crew on site at 0800 hours 6/24/87.

G. OSC contacts Upper Southampton Police Department at approx. 1440 hours apprising them of planned site activities. Police and Fire Dept. reps on site within minutes of notification; offered two equipment and personnel to erect barriers, snow fence, and banner guard around the Zhivalyuk yard to prevent unauthorized entry. Security measures completed by 1600 hours. All Twp. personnel off site by 1700 hours.

H. Homeowners meeting held 1830 hours near site. OSC explained PRP status and future site activities.

I. OSC and TAT continue to investigate possible avenues of contamination of this property with mercury. Preliminary visual review of neighboring areas reveals this to be an isolated incident. Previous owners of this and adjacent properties since building construction were identified and contacted if possible this date; no clues to spill obtained.

J. OSC informed that mercury vapor analyser recommended by TAT for use in on site monitoring during removal activities is not available until 6/25/87 due to calibration at company of origin. CDC McDurdy and Gray condone use of Level C with cartridges specific for contaminant mercury at this site.

K. OSC and TAT off site 2000 hours.

III. Future Plans

A. Removal activities to begin 0800 hrs. 6/24/87.

B. TAT to finalize \$50K funding documentation 6/24/87.

C. PADER and EPA Public Affairs (Hal Yates) to be on site 6/24/87.

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D. ERCS arranging for analytical, transport, and disposal of excavated materials.

E. TAT to prepare and implement soil sampling plan for 0-6" cores and surface grabs on and around the property 6/24/87.

F. OSC awaiting PADER and property owner lab results due in near future.

Garrett Arai, On-Scene Coordinator
USEPA Region III
Philadelphia, PA

AR100053

DRAFT

To: ERD/DEER (EPA5511)
To: T. MASSEY (EPA9374)
From: T. MASSEY (EPA9374) Delivered: Wed 24-June-87 20:26 EDT Sys 163 (1
Subject: TROWBRIDGE MERCURY SITE POLREP #2
Mail Id: IPM-163-870624-185440073

TROWBRIDGE ESTATES MERCURY SITE
FEASTERVILLE, BUCKS COUNTY, PA
CERCLA REMOVAL ACTIVITY

ATTN: TOM MASSEY AND TIM FIELDS

POLREP #2

I. SITUATION: (1800 HRS. 6/24/87)

- A. PERSONNEL ON SCENE: EPA-2, TAT-4, PADER-2, LOCAL-12, TAT-4, ERCS-4.
- B. WEATHER: SUNNY, TEMPS. IN THE UPPER 80'S.
- C. ESTIMATED COSTS TO DATE:

AGENCY	CURRENT	CEILING
EPA	\$ 600	\$ 5 K
TAT	2,100	10 K
ERCS	3,000	30 K
HQ 15%	895	5 K
TOTALS	\$6,595	\$ 50 K
- D. MERCURY VISIBLE JUST BENEATH SOD LAYER (APPROX. 3 IN.) TO A DEPTH OF 6 INCHES.
- E. FOUR DRUMS OF EXCAVATED SOIL REMOVED THIS DATE AND STAGED ON SITE UNTIL DISPOSAL ARRANGEMENTS CAN BE MADE.
- F. DR. PETE LEDERMAN (WESTON ZPMO) ON SCENE TO ASSIST TAT WITH SITE ACTIVITIES.
- G. BUCKS COUNTY COURIER TIMES PHOTOGRAPHER AND REPORTER ON SCENE SPEAKING WITH USC.

II. ACTIONS TAKEN

- A. ERCS (GUARDIAN) EXCAVATED FOUR DRUMS OF MERCURY CONTAMINATED SOIL BY HAND. EXCAVATED AREAS WERE DETERMINED BY VISUAL INSPECTION BY OSC AND TAT.
- B. TAT COLLECTED SIXTEEN (16) SOIL SAMPLE THIS DATE. SAMPLES WERE PICKED UP BY LAB (WASTEX) AND ARE TO BE ANALYZED FOR TOTAL MERCURY. LAB INDICATED THAT THEY COULD PROVIDE A FOUR (4) HOUR TURNAROUND.

- AR100054
- C. OSC CONTACTED EPA OPA AND ENFORCED WITH UPDATE OF

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SITE STATUS.

- D. EPA/OPA (HAL YATES) ON SCENE AND CONTACTED/UPDATED RESIDENTS OF SITUATION.
- E. PADER (MIKE PINDRELLA AND GEORGE DANYLLA) ON SCENE TO ASSIST WITH SITE ACTIVITIES.

ACTIONS TAKEN (CONT.)

- F. ATTORNEY FOR TROWBRIDGE ASSOCIATION BRIEFED BY OSC.
- G. DISPOSAL ARRANGEMENTS FINALIZED BY ERCS. WASTE ACCEPTED BY CHEM WASTE MGMT. EMELLE, ALA. OSC DIRECTED ERCS TO ARRANGE FOR OTHER TRANSPORTATION AFTER RECEIVING EXTREMELY HIGH TRANSPORTATION RATES FROM AND FOR A MILK RUN.
- H. OSC CONTACTED BIGLIOTTI TO GET INFORMATION ABOUT THE FILL DIRT USED FOR THE DEVELOPMENT WHICH IS BELIEVED TO BE THE SOURCE FOR THE MERCURY.

III. FUTURE PLANS

- A. AWAITING ANALYTICAL RESULTS FROM LAB. DUE 0800 HRS 6/25/87.
- B. DECISIONS TO BE MADE AFTER RECEIVING ANALYTICAL:
 - 1. PROCEED WITH EXCAVATION
 - 2. DETERMINATION OF HOW CLEAN IS CLEAN
 - 3. NECESSITY FOR RESAMPLING
 - 4. REPLACE SOD AND CLOSE OUT SITE
- C. SITE SECURITY TO BE ON SCENE THIS EVENING.
- D. DRUMS TO BE TRANSPORTED TO CWM, EMELLE, ALA.

OSC GARRETT ARAI
U.S. EPA REGION III
PHILADELPHIA, PA

To: ERD/DERR (EPASS11)
To: T. MASSEY (EPA9374)

AR100055

DRAFT

To: ERD/DEER (EPAS211)
To: T. MASSEY (EPA9374)
From: T. MASSEY (EPA9374) Delivered: Fri 26-June-87 7:57 EDT Sys 1b3 (77)
Subject: mercury site
Mail Id: IPM-163-870626-071680780

POLREP#3

Trowbridge Estates Mercury Site
Southampton Twp., Bucks Co., PA
ATTN: T. Massey and T. Fields

I. Situation (6/25/87 2000 hours)

A. Excavation continues based on visual observations and lab results obtained this date on samples taken CCB 6/24/87. Lab results indicate mercury contamination limited to select areas on the Zhivalyuk property; mercury has been found during excavation at 8-10" below ground surface this date. Samples taken after excavation 6/25/87 sent to lab for quick turnaround. Site security being maintained.

B. Personnel on site:

EPA-1
TAT-3
ERCS-3
Security-1

C. Weather- hot, humid, low 90's

II. ACTIONS TAKEN

A. OSC, TAT and ERCS on site this date (approx. 1530 hours) to continue excavation after lab results obtained verbally at 1130 hours indicate contamination remains in hot spots. Mercury concentration remaining in areas excavated 6/24/87 range from 14.8 to 640 mg/kg in hot spots, with other areas below USES background soil conc. of .09 ppm Hg. Excavation continued until 1950 hours this date, with close visual inspection of shovelled soil by ERCS and TAT before disposal in overpacks. Due to the finding of earthworms in the excavated areas, the OSC believes that mercury spilled on the ground surface may have reached the clay strata via their pathways as exposed to being brought in with the subsurface fill.

B. OSC notified neighborhood residents in the area of site activities. Residents of 703 Grantham, immediately adjacent to the site, were informed of the removal and gave permission for TAT to enter the property and visually inspect their yard for mercury contamination.

C. A total of 8 55-gal. overpacks filled on site. Seven contain excavated soil, one contains protective clothing and refuse.

D. TAT and ERCS conducted close search of Zhivalyuk property on hands and knees looking for elemental mercury. No additional contaminated areas found. Search to continue throughout immediate neighborhood 6/27/87.

AR100056

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E. Air monitoring this date by TAT with mercury vapor analyser revealed no readings above low range TLV in excavated areas.

F. ERCS Response Mgr. delivered samples of cleaned areas taken by TAT this date to lab for quick turnaround.

III. FUTURE PLANS

A. OSC awaiting lab results from cleaned areas, due verbally by 1100 hours 6/27/87. Site activities to resume this date with either backfilling and resodding the property if samples are clean, or continued excavation if samples are hot. Clean samples will indicate abatement of the immediate threat to public health presented by this site.

B. OSC awaiting lab results from PADER, due 6/28/87, and Zhivalyuks, due date unknown.

C. OSC to prioritize completion of OSC report and relinquish all information to Henry Dawe, EPA Enforcement asap.

D. Site restoration or continued removal to continue 6/27/87.

Barrett Arai, OSC
EPA Region III
Philadelphia, PA

AR100057

DRAFT

POLREP#4

Trowbridge Estates Mercury Site
Southampton Twp., Bucks Co., PA
ATTN: T. Massey and T. Fields

I. Situation (Fri., 6/26/87 2000 hrs.)

A. Verbal results received this date indicate mercury contamination remains in excavated areas up to 400 ppm in depths of up to eight inches. OSC, ERCS and TAT return to site to continue removal, based on ATSDR recommendation to excavate to 12" , cover, and revegetate. Additional excavation performed this date. PADER recommended sampling re-excavated areas to assure mercury removal, although this sampling not required by ATSDR. OSC accommodated PADER suggestion and cleaned areas resampled. Ten drums of waste removed from site to Chem Waste in Emelle, AL for disposal. Samples hand delivered to local lab for quick turnaround.

B. Personnel on site:

EPA-1

TAT-3

ERCS-2, not inc. driver

C. Weather: Raining, mid-80's

II. ACTIONS TAKEN

A. OSC received verbal results on 6/25 samples at approx. 1100 hours. Mercury contamination remained in isolated areas up to 400 ppm. OSC contacted ATSDR (Atlanta) for advice and guidance on continued actions at approx. 1140 hours. ATSDR recommended excavation to 12" and covering with clean fill and sod.

B. As per OSC instruction, TAT on scene at 1320 hours to visually inspect neighboring properties for signs of mercury contamination and take soil cores from Zhivalyuk yard for visual inspection. No signs of mercury evident among the ten residential properties reviewed this date and 6/25/87, or in Zhivalyuk cores (5 cores, 12-15" deep).

C. PADER rep. George Daniliew, Norristown Office, on site approx. 1500 hours. Expressed concern with future use of the property which may require excavation below the 12" level, e.g. gardening. OSC agreed to resample areas cleaned this date before backfilling. Four composite samples taken and sent to local lab for quick turnaround at approx. 2000 hours.

D. Transporter for drums (S&J Trucking) on scene 1535 hrs. Ten drums D009 waste transported to Emelle, AL for disposal at 1950 hours.

E. OSC, TAT, ERCS off site 2000 hours.

III. FUTURE PLANS

A. OSC awaiting lab results from resampling today; verbals expected by 1100 hours 6/27/87.

B. Completion of site activities expected Sat. 6/27/87.

Garrett Arai, OSC
EPA Region III
Philadelphia, PA

AR100058

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POLREP #5
Trowbridge Estates Mercury Site
Southampton Twp., Bucks Co., PA
ATTN: T. Massey and T. Fields

I. Situation (1700 hours, Sat. 6/27/87)

A. ERCS, TAT on site this date to backfill and resod excavated areas as per OSC instruction. Verbal results received this morning reveal only one composite sample had over 1.0ppm mercury (highest concentration was 48 ppm). From this data and visual inspections it appears that this CERCLA removal is complete. Property owners contacted today by OSC and informed of completion.

B. Personnel on scene:

TAT-1

ERCS -3

C. Weather- Raining through 6/27 noon

D. Estimated Costs to date:

EPA-\$1k

ERCS-\$30K

TAT-\$2k

II. Actions Taken

A. ERCS Resp. Mgr. contacted TATM Donegan at 1045 hrs. with lab results. Samples indicated areas cleaned substantially with excavation of 6/25. TAT contacted OSC Arai with report; OSC instructs site crew to backfill and resod to complete removal activities.

B. ERCS, TAT on site by 1230 hours to backfill and resod excavated areas. Rains overnight had filled excavations to ground surface, which required bailing. All areas refilled and sodded; security fencing removed and Twp. Police contacted as per their earlier request to pick up Twp. materials.

C. TAT informed resident of 700 Trowbridge Ave. that sample obtained from his property was not contaminated with mercury.

D. ERCS, TAT off site 1540 hours. OSC notified of removal completion.

III. FUTURE PLANS

A. No further emergency response actions foreseen for this site. The immediate threat to public health and the environment has been mitigated by the removal of the mercury both above and below the ground surface in the areas found to be contaminated.

B. OSC report to be prioritized; completion of draft expected within one week.

Garrett Arai, OSC
USEPA Region III
Philadelphia, PA

AR100059

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must be legibly filled in, in ink, in indelible Pencil, or
Carbon, and retained by the Agent.

Shippers Number

Carriers Number **19248**

SCAC

Date _____

FROM: U.S. EPA - 701
Shipper Grantham Court
Street
Origin South Hamilton Pa ZIP

Route:

Vehicle Number 1802

No Shipment Units	HM	Kind of Packages, Description of Articles (If HAZARDOUS MATERIALS, PROPER SHIPPING NAME)	HAZARD CLASS	ID Number	WEIGHT (subject to collection)	HALL	TAGS REQUIRED (or exemption)
10	Dr	Hazardous WASTE SOLID	MS. CORN	9189	5000		
		Arr: 3:30 PM	Dep: 7:45 PM				

Remit C.O.D. to:

Address:

City:

State:

Zip:

COD Amt: \$

C.O.D. Fee:

Prepaid ☐Collect ☐ \$

NOTE - Where the rate is dependent on value, shippers are required to state specifically in writing the agreed or declared value of the property. The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding \$ _____ Per _____

1. The Government of India has decided to grant a 10% increase in the minimum wages of the workers employed in the public sector.

FREIGHT CHARGES

☐ PREPAID ☐ COLLECT[illegible]

It is to certify that the above named materials are properly classified, declassified, packaged, marked and labeled and are in proper condition for shipment in accordance with the applicable regulations of the Department of Transportation.

PLACARD'S RECORDED

1997, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 2680, 26

☐ YES ☐ NO-FURNISHED BY CARRIER
DRIVER SIGNATURE:

SHIPPER: X *General & Co*
PER: *President of USA*
DATE: *6/26/52*

CARRIER: S-J Transportation Co. - Woodstown, NJ 08098

PER: President's USA

PER: Don Donk

DATE: 6/24/6

DATE: 10-26-87

FORM # 9-BLS-1 (3.P.4)

Agent must detach and retain this Shipping Order and must sign the Original Bill of Lading

FOR HELP IN CHEMICAL EMERGENCIES INVOLVING SPILL, LEAK,
FIRE OR EXPOSURE CALL TOLL-FREE 1-800-424-9300 DAY OR NIGHT

AR100060

DRAFT

Please print or type (Form designed for use on 12-pitch typewriter)

Form Approved OMB No. 2000-0404. Expires 7-31-86

UNIFORM HAZARDOUS WASTE MANIFEST		21. Generator's US EPA ID No. <i>PA1000000000</i>	Manifest Document No.		2. Page 1 of	Information in the shaded areas is not required by Federal law.	
3. Generator's Name and Mailing Address <i>3110 S. 1st St. #100 Chicago, IL 60605</i>					A. State Manifest Document Number		
4. Generator's Phone <i>312-555-1234</i>					B. State Generator's ID <i>PA1000000000</i>		
5. Transporter 1 Company Name <i>S. J. Transport</i>		6. US EPA ID Number <i>PA1000000000</i>		C. State Transporter's ID <i>PA1000000000</i>			
7. Transporter 2 Company Name		8. US EPA ID Number		D. Transporter's Phone <i>312-555-1234</i>			
9. Designated Facility Name and Site Address		10. US EPA ID Number		E. State Transporter's ID			
				F. Transporter's Phone			
				G. State Facility's ID			
				H. Facility's Phone			
11. US DOT Description (Including Proper Shipping Name, Hazard Class and ID Number)					12. Containers	13. Total Quantity	14. Unit Wt/Vol
					No.	Type	Waste No.
a. <i>Hazardous Waste, Code 1000</i>							<i>1000</i>
b.							
c.							
d.							
J. Additional Descriptions for Materials Listed Above					K. Handling Codes for Wastes Listed Above		
15. Special Handling Instructions and Additional Information <i>CHM 15751</i>							
16. GENERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national governmental regulations.							
Printed/Typed Name <i>Michael D. Aron</i>					Signature <i>Michael D. Aron</i>		
17. Transporter 1 Acknowledgement of Receipt of Materials					Date Month Day Year <i>1 1 7</i>		
Printed/Typed Name <i>S. J. Transport</i>					Signature <i>S. J. Transport</i>		
18. Transporter 2 Acknowledgement of Receipt of Materials					Date Month Day Year		
Printed/Typed Name					Signature		
19. Discrepancy Indication Space							
20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19.							
Printed/Typed Name <i>PA1000000000</i>					Signature <i>PA1000000000</i>		
					Date Month Day Year		

FILE COPY OR STATE COPY

DRAFT

Please print or type (Form designed for use on elite (12-pitch) typewriter)

Form Approved OMB No. 2000-0404 Expires 7-31-86

UNIFORM HAZARDOUS WASTE MANIFEST		21. Generator's US EPA ID No <i>PAF000000105</i>		Manifest Document No <i>000001</i>		2. Page 1 of 1	
3. Generator's Name and Mailing Address <i>841 Clinton St. N. W. Atlanta, GA 30308</i>						A. State Manifest Document Number	
						B. State Generator's ID <i>PAF000000105</i>	
4. Generator's Phone <i>(404) 527-6770</i>						C. State Transporter's ID <i>102224247</i>	
5. Transporter 1 Company Name <i>SA Transport</i>						D. Transporter's Phone <i>404 7612741</i>	
7. Transporter 2 Company Name						E. State Transporter's ID	
8. US EPA ID Number <i>102224247</i>						F. Transporter's Phone	
9. Designated Facility Name and Site Address						G. State Facility's ID	
10. US EPA ID Number						H. Facility's Phone <i>205 662 1731</i>	
11. US DOT Description (Including Proper Shipping Name, Hazard Class and ID Number) <i>16 113. Hazardous Waste Solid a.s. ORME NH719</i>						12. Containers	
						No. Type	
						10 015,000 1B 0009	
J. Additional Descriptions for Materials Listed Above						K. Handling Codes for Wastes Listed Above	
15. Special Handling Instructions and Additional Information <i>04M 139351</i>							
16. GENERATOR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national governmental regulations.							
Printed/Typed Name <i>Garcett H. Arai</i>				Signature <i>Garcett H. Arai</i>		Date <i>06/26/87</i>	
17. Transporter 1 Acknowledgement of Receipt of Materials				Signature <i>[Signature]</i>		Date <i>06/26/87</i>	
Printed/Typed Name <i>[Name]</i>				Signature <i>[Signature]</i>		Date <i>06/26/87</i>	
18. Transporter 2 Acknowledgement of Receipt of Materials				Signature		Date	
Printed/Typed Name				Signature		Date	
19. Discrepancy Indication Space							
20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in item 19.							
Printed/Typed Name <i>AR100062</i>				Signature <i>[Signature]</i>		Date <i>Month Day Year</i>	

DRAFT

KS

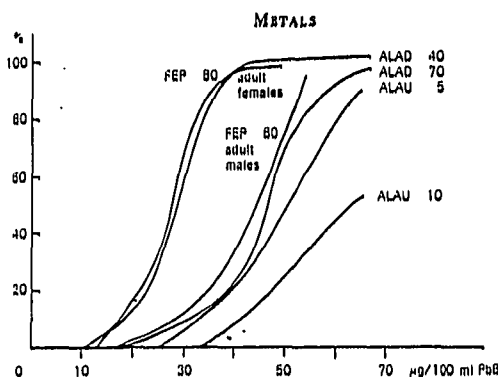


Figure 17-5. Dose-response relationships for effects of lead on heme intermediates. The ordinate represents percent respondents for the various effects.

Effects:

FEP = Concentration of erythrocyte porphyrin concentration, expressed as $\mu\text{g}/\text{dl}$ packed cells.

ALAD = Aminolevulinic acid dehydrase activity in blood, expressed as % inhibition.

ALAU = Concentration of aminolevulinic acid in urine, expressed as mg/dl .

(From Zielhuis, R. L.: Dose-response relationships for inorganic lead. *Int. Arch. Occup. Health*, 35:1-18, 19-35, 1975.)

dose is measured must correspond to the time at which the effect occurs. Alternatively, the dose must not change during the lag period between occurrence of effect and actual measurement of effect. These conditions are rather difficult to satisfy. As a matter of fact, it can only be done satisfactorily with regard to lead effects on heme synthesis. A good example of how dose and effect change together was provided in a prospective study of newly hired lead workers. As PbB rose, ALAD activity fell more or less concurrently (Fig. 17-4). As would be expected, the response of the workers varied both as to the PbB in the work environment and as to the magnitude of ALAD inhibition. The interindividual variability in response is expressed in the form of dose-response curves. For lead effects on heme synthesis, estimates can be made of the percent respondents. This is illustrated for the major effects of lead on heme synthesis that have been under discussion (Fig. 17-5). The elaboration of dose-response curves is useful only if the particular effect (e.g., FEP > 80) has some health significance.

Treatment of Lead Poisoning

It is extremely difficult to evaluate the benefits of therapeutic regimens for the treatment of lead poisoning, or other metallic poisons for that matter. To begin with, the incidence of frank poisoning and the corresponding amount of clinical experience is low compared to many other diseases, e.g., hypertension or the common

headache. Further, the wide spectrum of manifestations of illness among cases makes it extremely difficult to compare responses to various regimens. In adults and children both, the major specific therapeutic objective is removal of lead from the body using chelating agents. In adults the most widely accepted procedure is intravenous infusion of the calcium salt of disodium ethylenediamine tetraacetate (CaEDTA), 1 to 2 g per day, for 4 to 5 consecutive days. The lead chelate formed by exchange of Ca for Pb is excreted promptly in the urine. Curiously, the major source of lead mobilized in this manner is the bones (Hammond, 1971).

The treatment of lead poisoning in children also entails a course of CaEDTA therapy, either alone or in combination with dimercaptopropanol (BAL). Combined therapy has been found to be more effective than therapy with either drug alone (Chisolm, 1970).

MERCURY

Introduction

It is "the hottest, the coldest, a true healer, a wicked murderer, a precious medicine, and a deadly poison, a friend that can flatter and lie." [Woodall, J.: *The Surgeon's Mate or Military & Domestic Surgery*. London, 1639, p. 256]*

There has always been an aura of magic surrounding mercury. Even the name, shared by a

* Quoted from *ABJ* 100:63

Roman god and a distant planet, and the lustrous liquid appearance of this metal suggest magic. Before the time of Christ and even to this day, magic properties have been ascribed to mercury. It occupied a central role among alchemists in the transmutation of base metals into gold. It was carried about as amulets to ward off disease and other evils. At various times down through the centuries it has been used to treat almost every ailment known to man. Even to this day it is used to a limited extent for therapeutic purposes. Its toxic properties, however, were not unappreciated. It has long been widely condemned as being a drug with no reasonable margin of safety, even at a time when it was being used widely, notably for the treatment of syphilis. Even the characteristics of occupational intoxications were described in the Middle Ages.

Man is apparently a poor student of history. Mercury poisoning still occurs to some extent in certain occupations, principally from inhalation of mercury vapor. There also have occurred episodes of environmental contamination with organic forms of mercury, principally methyl mercury. The most widely known such episode occurred in Minamata Bay, Japan, from 1953 into the early 1960s. This was followed by a similar episode in Niigata, Japan. In both cases the cause was consumption by the local inhabitants of fish that were contaminated with mercury from industrial waste. In all, 1,200 cases of poisoning were reported. Even more extensive episodes have resulted from contamination of bread made from cereal grains treated with alkyl-mercury fungicides. The largest of these episodes occurred in Iraq, 1971-1972. It involved some 6,000 cases and 500 deaths.

At the time that outbreaks of methyl mercury poisoning in Japan were under active investigation, Swedish scientists found high concentrations of methyl mercury in freshwater fish. The sources of mercury were mainly chloralkali plants, drainage of fields in which cereal grain seeds had been treated with mercury, and wood pulp plants. Methylation of mercury occurred due to the action of aquatic organisms, leading to transfer and bioconcentration up the food chain to the large carnivorous fish. For more details concerning the environmental significance and toxicology of mercury, there are two good recent reviews (Clarkson, 1972; WHO, 1976).

Metabolism

The chemical form of mercury has a profound influence on its disposition. For all practical purposes there are three general forms of mercury.

1. Elemental mercury— Hg^0 . This form is of considerable importance to toxicologists because

It has a high vapor pressure. A saturated atmosphere at 21° C contains approximately 18 mg/M³. Of equal significance is the fact that the vapor exists in a monoatomic state. It is therefore distributed primarily to the alveolar bed upon inhalation. Finally, metallic mercury has limited but toxicologically significant solubility in water (20 µg/l) and organic solvents (2.7 mg/l in pentane).

2. Inorganic Mercury— Hg^{1+} and Hg^{2+} . Of these two oxidation states, Hg^{2+} is the more reactive, readily forming complexes with organic ligands, notably sulfhydryl groups. In contrast to $HgCl_2$, which is both highly soluble in water and highly toxic, $HgCl$ is highly insoluble and correspondingly less toxic.

3. Organic Mercury. These compounds are of diverse chemical structure. As the term is used here, organic mercury refers to all compounds in which mercury forms a bond with one carbon atom. For all practical purposes, the group is limited to methyl and ethyl mercury, phenyl mercury, and the family of alkoxyalkyl mercury diuretics.



These organic cations form salts with inorganic and organic acids, e.g., chlorides and acetates. They also react readily with biologically important ligands, notably sulfhydryl groups. Finally, they pass readily across biologic membranes since they are lipid soluble. The major difference among these various organomercury cations is that the stability of the carbon-mercury bonds *in vivo* varies considerably. Thus, the alkyl mercury compounds are considerably more resistant to biodegradation than either phenyl mercury or the alkoxyalkyl mercury compounds.

Absorption

For elemental mercury the most important route of absorption is the respiratory tract. As would be expected from the mono-atomic nature and lipid solubility of mercury vapor, percent deposition and retention are quite high, of the order of 80 percent in man. Although confirmatory data are not available, monoalkyl mercurials (e.g., methyl mercury) probably also are deposited and retained to a high degree, since they have high vapor pressures and high lipid solubility.

Elemental mercury is very poorly absorbed from the gastrointestinal tract, probably less than 0.01 percent. This may be because, unlike in the lungs, mercury is not in a monoatomic state but, rather, occurs as large globular particles. Inorganic mercury in food is absorbed to the extent of about 7 percent, and organic mercury com-

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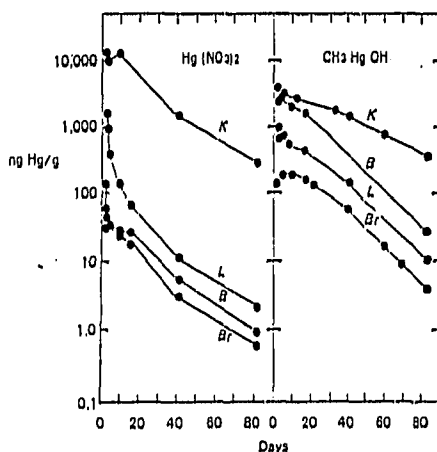


Figure 17-6. The fate of single doses of inorganic mercury and methyl mercury in rats. (Modified from Swenson, A., and Ulfvarson, U.: Distribution and excretion of mercury compounds in rats over a long period following a single injection, *Acta Pharmacol. Toxicol.*, 26:273-33, 1968.)

pounds are very efficiently absorbed, owing to their lipid solubility. For example, the absorption of methyl mercury, even mixed with food, is 95 percent in adults.

As with all metals, the degree of skin absorption in man is not known with any precision. Systemic absorption of alkyl mercurials probably is substantial. People have been poisoned as a result of dermal application of methyl mercury ointments. Some absorption of elemental mercury and even of inorganic salts of mercury occurs. Thus, in experimental animals, 5 percent of an aqueous solution of mercuric chloride was absorbed through the skin of guinea pigs within five hours (Skog and Wahlberg, 1964).

Distribution and Metabolism

The distribution of mercury varies considerably, depending on the chemical form and, to a lesser extent, on the route of administration. Elemental mercury is rapidly oxidized to Hg^{2+} and organic mercury compounds are also to varying degrees metabolized to yield Hg^{2+} . As far as tissue affinity is concerned, the most outstanding single characteristic of mercury is its affinity for the kidney. This is true both for Hg^{2+} and for the organic mercury cation R-Hg^+ .

The disposition of inhaled elemental mercury vapor is of special interest because of the importance of intoxication by this route. It has long been known that Hg^0 is rapidly oxidized in the erythrocytes to Hg^{2+} , even *in vitro*. Yet, while chronic mercury poisoning due to intake of Hg^{2+} is essentially a renal problem, chronic mercury poisoning due to inhalation of Hg^0 is a disease of

the central nervous system. This apparent paradox is explained by the fact that transfer of the lipid-soluble Hg^0 from the blood to the brain is sufficiently rapid to result in a toxicologically significant differential distribution to that organ (Magos, 1967). The subsequent oxidation of Hg^0 in the brain serves to trap it there. A similar selective distribution occurs in the fetus. The oxidative process is enzyme mediated, with the catalase complex being the most likely site of oxidation.

The disposition of organic mercury compounds is, in general, quite unlike that of Hg^{2+} . This is particularly true of the short-chain alkyl mercury compounds, notably methyl mercury. Figure 17-6 compares the fate of single equal subcutaneous doses of Hg as Hg^{2+} and as methyl Hg . Although both forms of mercury distribute preferentially to the kidney, the concentration in the brain and blood is substantially higher in the case of methyl mercury. Toxic manifestations of inorganic mercury are renal whereas those for methyl mercury poisoning are neurologic.

The disposition of phenyl mercury is essentially the same as for inorganic mercury. This is because the carbon-mercury bond is rapidly cleaved *in vivo*, yielding benzene and Hg^{2+} . The benzene is subsequently oxidized to phenol, conjugated, and excreted. Alkyl and alkoxyalkyl mercury compounds also are subject to some carbon-mercury bond cleavage, but the mechanism whereby this occurs is poorly understood (Gage, 1975). In general, cleavage occurs much more slowly than with phenylmercury. Rate of clearance from the body varies a great deal. In some cases, as with

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alkoxyalkyl mercurials used as diuretics, clearance is much faster than for Hg^{2+} . In other cases, as with methyl mercury, clearance is considerably slower than for Hg^{2+} .

Mercury moves readily across the placenta into fetal tissue. Regardless of the chemical form administered, fetal tissues attain concentrations of mercury at least equal to those of the mother. In fact, in the case of exposure to Hg vapor and to methyl mercury, fetal concentrations exceed those of the mother to varying degrees, depending on the species, duration, and absolute level of maternal exposure. Fetal intoxication by way of the mother has been documented in cases of methyl mercury poisoning.

In the earlier section of this chapter dealing with lead, evidence was presented for the existence of a metal-sequestering mechanism, stimulated by the metal itself. Evidence for such a mechanism also exists for mercury. Metallothionein, a low-molecular-weight protein rich in sulfhydryl groups, was originally isolated from horse kidney. It has a high affinity for zinc, cadmium, and mercury. Administration of any one of these metals stimulates the synthesis of metallothionein. The renal concentration of metallothionein is increased as much as sixfold by administration of inorganic mercury. It may serve a protective role for the kidney by sequestering mercury, since the minimal concentration of mercury in kidney associated with toxic effects is considerably greater with chronic administration than with acute administration. The role of metallothionein in toxicology is discussed further in the section on cadmium.

As with lead, the concentration of mercury in the blood has been used as a biologic indicator of exposure. The distribution between blood cells and plasma is dependent on the chemical form. Thus, with methyl mercury exposure the concentration ratio, whole blood/plasma, is approximately 20, while with exposure to mercury vapor the ratio is only slightly above unity (Lundgren *et al.*, 1967). Measurement of mercury in blood has been extremely useful in assessing safe steady-state levels of methyl mercury exposure in man.

The kinetics of methyl mercury disposition are fairly straightforward and simple. Elimination rates as determined in human volunteers receiving single radioactive tracer doses indicate that the clearance of the dose from the body is adequately described by a single exponential elimination constant. The clearance half-time from these studies was found to be about 70 days. This rate of elimination seems to hold over a range of input rates. Thus, the rate of disappearance of mercury from the blood of hair biologists who consumed moderate or large amounts of fish or

bread contaminated with methyl mercury for long periods of time was quite consistent with the clearance half-time for the amount administered as a tracer dose to volunteers. For other forms of mercury the biologic half-life is not so well described. Limited data suggest, however, that the biologic half-life of inorganic mercury is only about 40 days in man, as contrasted to 70 days for methyl mercury.

Excretion

The relative contribution of urine and feces to the total elimination of mercury is, as with other features of mercury metabolism, quite variable depending on the particular form of mercury in the body. Upon prolonged inhalation of mercury, urinary excretion somewhat exceeds fecal excretion. The same probably applies to mercury administered as Hg^{2+} . The rate of urinary excretion for any one individual fluctuates considerably from day to day even under steady-state exposure conditions but has been found in industry to be roughly proportional to the level of air exposure. The mechanism of renal excretion of mercury is complex. The weight of evidence suggests that glomerular filtration contributes little to the renal excretion of any form of mercury. The mechanisms whereby the tubules release mercury into the lumen of the nephron are not well understood. At nephrotoxic doses of inorganic mercury, however, a substantial excretion occurs by exfoliation of renal cells.

In contrast to the excretion of inorganic mercury, methyl mercury is excreted mainly in the feces. Two separate processes are involved: biliary excretion of methyl mercury and excretion by exfoliation of intestinal epithelial cells move mercury into the intestinal lumen. Intestinal reabsorption of the mercury, however, substantially cancels the biliary contribution to net excretion. A polythiol resin has been developed that short-circuits this enterohepatic recirculation. When the resin is given orally it traps the mercury excreted into the bile and carries a substantial fraction of it out into the feces (Clarkson *et al.*, 1973). This procedure has been demonstrated to accelerate mercury excretion in human cases of poisoning (Bakir *et al.*, 1973).

Biologic Effects

As in the case of lead, mercury has toxic effects involving numerous organs and systems. Some have been clearly shown to occur in man under current and recent circumstances of exposure. Others either are of historic interest or are phenomena that have been demonstrated only in animal models. The relevance of these to the human condition is in many cases uncertain.

Regardless of all that, our present perceptions suggest that, irrespective of the chemical form of mercury, the major target organs are the central nervous system and the kidney. As will be seen, there is no sound basis for concluding that this is because the toxic actions of the various chemical forms can be attributed to a single common metabolic, e.g., Hg^{2+} .

Central Nervous System. The most consistent and pronounced effects of exposure to both elemental mercury vapor and to short-chain alkyl mercury compounds are on the central nervous system. There are similarities but there also are distinct differences. The effects of mercury vapor exposure are strikingly neuropsychiatric in nature whereas those resulting from methyl mercury exposure are largely of a sensorimotor nature. Certain effects are similar in both types of exposure, however, notably tremor. In mercury vapor exposure the tremor progresses in severity with duration of exposure. Initially it involves only the hands but later may spread to other parts of the body. Tremors are triggered by voluntary use of the affected muscles (intentional tremor). Neuropsychiatric signs also occur at relatively low levels of exposure, notably excessive shyness, insomnia, and emotional instability with depressive moods and irritability most frequently noted. This neuropsychiatric complex is known as "erethism."

Tremor also occurs in methyl mercury intoxication, but other effects not seen in mercury vapor exposure occur more consistently and at lower exposure levels. These are sensory in nature. The earliest signs are paresthesias and constriction of the visual field. At somewhat higher levels of exposure other sensory effects occur, such as loss of hearing, of vestibular function, and of the senses of smell and taste. These effects are not known to occur in elemental mercury intoxication. Numerous other neurologic effects occur in methyl mercury intoxication. These are motor effects such as incoordination, paralysis, and abnormal reflexes. It is not clearly known whether motor neurons are uniquely involved. Some of these motor effects, e.g., incoordination, could result from defects in sensory input.

Neuropsychiatric effects, which are so prominent in elemental mercury exposure, are also reported to occur in methyl mercury poisoning, but not so consistently. Further, the effects seem somewhat different from those observed in elemental mercury poisoning. Thus, shyness and irritability are not observed in methyl mercury poisoning but are very prominent in elemental mercury poisoning. On the other hand, spontaneous fits of laughing and crying and intellectual deterioration occur only in methyl mercury poisoning.

The pathogenetic mechanism of neurotoxicity has been investigated intensively in recent years, particularly concerning methyl mercury. The various approaches used reflect the diversity of toxic phenomena exhibited. Thus, the problem has been viewed from the neuroanatomic standpoint as well as from the biochemical, neurophysiologic, and pharmacologic standpoints. Chang (1977) has reviewed these studies and has proposed a tentative pathogenetic mechanism, which applies primarily to methyl mercury because relatively few of the studies have dealt with inorganic mercury or have directly compared effects of the inorganic and alkyl forms.

Both inorganic and alkyl mercury disrupt the integrity of the blood-brain barrier as manifested by extravasation of plasma protein into adjacent cerebral tissue. Since the blood-brain barrier acts to regulate the uptake of amino acids and other metabolites, it is possible that brain metabolism is affected at this point of interface with the circulation. The actions of mercury are probably not limited to the blood-brain barrier, however. Both forms of mercury are widely distributed elsewhere in the central nervous system, but there are quantitative differences. For example, while both forms of mercury localize to a high degree in dorsal root ganglion neurons and nerve fibers, inorganic mercury has a lesser degree of localization in neurons of the calcarine cortex than does methyl mercury. Degenerative changes are widespread in both forms of poisoning, although the nature of the changes differs in certain respects. In general, sensory neurons have been found to be more severely affected than motor neurons. Glial elements actually proliferate in areas of neuronal damage, perhaps to provide metabolic and structural support to the injured neurons. Damage is not limited to the cell bodies. Nerve fibers also are affected. Degeneration of both the axoplasm and the myelin sheath is common.

Biochemical explanations for the various degenerative changes abound. Enzymes along the glycolytic pathway and protein synthesis are inhibited. Inhibition of protein synthesis precedes both changes in anaerobic and aerobic glycolysis as well as neurologic effects. This "silent period" of several days between inhibition of protein synthesis and neurologic effects is seen even with single doses of mercury. It is not certain whether the inhibition is due to reduced amino acid uptake across the blood-brain barrier or whether the inhibition occurs by some other means.

Various neurophysiologic parameters also are altered by mercury. Spike potentials of sensory ganglionic neurons of animals receiving methyl mercury are prolonged, indicating retardation of repolarization. It has also been found that mercury blocks synaptic and neuromuscular trans-

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mission. The latter finding is of particular interest since a similar effect occurs in some cases of methyl mercury intoxication in man.

It is not possible at this time to say whether all the varied effects that have been noted experimentally occur as a result of independent actions of mercury or as stages in a chain of related events. Unitarian hypotheses are always attractive. There is none at present that adequately accounts for all the diverse neurologic phenomena that have been observed clinically and experimentally in mercury intoxication.

Kidney. By far the highest concentration of mercury occurs in the kidney, regardless of the chemical form absorbed. Yet, for all that, the kidney is the primary target organ only in the case of inorganic mercury (Hg^{2+}). At least this is so with respect to toxic effects. It is true that the kidney also is the primary target organ for non-toxic effects in the special case of the alkoxyalkyl mercury compounds used therapeutically as diuretics. It is also true that certain morphologic and functional effects are seen with sublethal doses of methyl mercury, but these are of uncertain significance in comparison to effects on the nervous system.

Massive oral doses of inorganic mercury, such as may be taken with suicidal intent, initiate a train of events beginning with anuria, progressing to polyuria, and finally to a recovery of normal renal function. The phase of anuria is the most life-threatening and may last for many days. The pathogenetic mechanism is not well understood. Experimental evidence from animal studies suggests that several factors are involved. These are tubular obstruction, increased back diffusion of tubular filtrate, and preglomerular vasoconstriction.

The phase of polyuria is characterized by decreased renal concentrating capacity. It probably results mainly from a substantial inhibition of proximal tubular sodium reabsorption. In severe poisoning, disturbances in tubular function may persist for several months after poisoning (Valek, 1965).

Acute inorganic mercury poisoning, as described above, is relatively rare. The more usual form of mercury nephrotoxicity occurs with chronic industrial exposure and is characterized by proteinuria. If severe, the nephrotic syndrome is observed, wherein the loss of plasma protein is sufficiently great to cause hypoproteinemia with edema of dependent parts, e.g., the ankles. Surprisingly, very little is known about the nature of the proteins that are excreted in cases of inorganic mercury poisoning. In one recent suicide attempt the proteinuria was mixed. Excretion of both albumin and low-molecular-weight proteins rose concurrently, suggesting both glomerular

and tubular damage. Exposure to inorganic mercury at levels sufficient to cause proteinuria does not result in increased amino acid excretion. It appears, therefore, that the renal tubular transport system for reabsorption of α -amino acids is less sensitive than the transport system for absorption of low-molecular-weight proteins.

Information concerning the effects of methyl mercury on renal function in man is nonexistent, except for statements to the effect that even in the presence of neurologic effects the kidney is seldom affected. This is consistent with experimental studies in rats in which subchronic exposure to methyl mercury caused moderate proteinuria only at a level of mercury administration that actually killed a substantial number of the animals.

Other Effects. Although the nervous system and the kidney are the usual major targets for effects of mercury, a variety of other toxic phenomena occur. Some of these are well-known accompaniments of clinical poisoning. Others are effects seen in experimental animals that may prove in the future to have significance for man.

In the case of mercury vapor inhalation, the neuropsychiatric problem resulting from chronic exposure is accompanied by stomatitis, gingivitis, and sometimes excessive salivation and a metallic taste. These tend to occur mainly in people whose oral hygiene is poor. A peculiar discoloration of the anterior surface of the lens in the eye also is frequent ("mercurialentis"). When people are exposed to very high concentrations of mercury vapor, pneumonitis occurs as a result of direct irritation of the lung. In the case of poisoning with inorganic mercury salts by mouth, severe inflammation of the mouth, esophagus, stomach, and small intestine occurs. Following this initial contact inflammation, a secondary inflammatory effect may occur wherein absorbed mercury localizes in the intestinal mucosa. The colon is peculiarly sensitive to this secondary inflammatory action. There also is a disease of infants known as acrodynia or "pink disease" in which inorganic mercury seems to play a role. It is characterized by neuropsychiatric disturbances, peripheral vascular effects, disturbances of sensation of the extremities, stomatitis, and other vague, nonspecific signs. The disease is not uniquely associated with excessive mercury exposure, nor does it occur regularly among children exposed to mercury. See Bidstrup (1964) for a detailed discussion of the role of mercury in this disease.

Dose-Effect and Dose-Response Relationships

It may be recalled that, with lead, it is possible to estimate both dose-effect and dose-response relationships in man. The critical system, the

hematopoietic system, is peculiarly amenable to quantitative estimates of effect. Thus, the activity of the enzyme ALAD in blood and the concentration of heme intermediates in blood and urine are readily quantifiable and exhibit clear relationships to the internal dose of lead, as reflected in the concentration of lead in the blood. The situation with mercury is not nearly so simple. To begin with, the critical effects both in the case of poisoning with elemental mercury and with alkyl mercury compounds are neurologic. Such phenomena as tremor, shyness, irritability in the case of elemental mercury and paresthesias and constriction of the visual field in the case of methyl mercury are not readily measured in quantitative terms. It is therefore not possible to construct dose-effect curves. So far as inorganic salts of mercury are concerned, the kidney is the critical organ. It is true that renal function is amenable to quantitative description, but even here there is a problem. The renal effect that seems to be the most sensitive index of mercury toxicity is elevated excretion of protein in the urine, an effect that has not been studied adequately to allow for definition of either dose-effect or dose-response relationships. For these reasons, it is

necessary to forego any thought of estimating dose-effect relationships for any form of mercury in man. As a matter of fact, even dose-response relationships can only be estimated for elemental mercury and methyl mercury exposures.

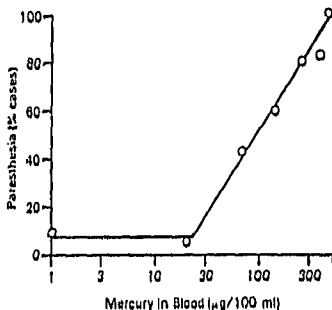


Figure 17-8. Dose-response relationship for methyl mercury, using concentration of mercury in the blood as dose and paresthesia as response. (WHO, 1976. From Bakir, F., et al.: Methylmercury poisoning in Iraq. An interuniversity report. *Science*, 181:230-41, 1973. Copyright 1973 by the American Association for the Advancement of Science.)

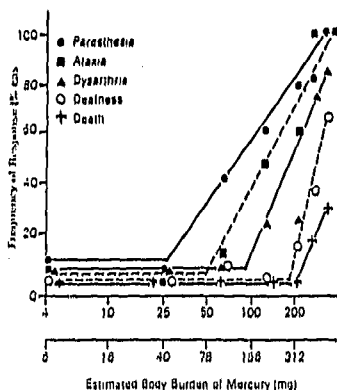


Figure 17-7. Dose-response relationships for methyl mercury. The upper scale of estimated body burden of mercury was based on the authors' actual estimate of intake. The lower scale is based on the body burden, which was calculated based on the concentration of mercury in the blood and its relationship to intake derived from radioisotopic studies of methyl mercury kinetics in human volunteers. (From Bakir, F., et al.: Methylmercury poisoning in Iraq. An interuniversity report. *Science*, 181:230-41, 1973. Copyright 1973 by the American Association for the Advancement of Science.)

In the case of elemental mercury vapor exposure the measurement of dose that seems to correlate best with response is the actual concentration of mercury breathed by the subjects, as contrasted to the concentration of mercury in the blood or urine of the exposed subjects. As the time-weighted average (TWA) air concentration rises above $100 \mu\text{g Hg}/\text{M}^3$, the frequency of occurrence of classic signs of erethism among workers increases (Smith et al., 1970). On this basis it has been recommended that the TWA limit for workers should be $50 \mu\text{g Hg}/\text{M}^3$ in order to provide some margin of safety.

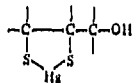
In the case of methyl mercury exposure, dose-response relationships have been calculated from the data obtained in the recent large-scale outbreak of poisoning in Iraq, described by Bakir et al. (1973). Again, as with elemental mercury exposure, the critical effects measured are those affecting the central nervous system. A hierarchy of response is seen with reference to sensitivity of the central nervous system. The effect occurring at the lowest level of exposure is paresthesia (Fig. 17-7). Both the estimated body burden of mercury (Fig. 17-7) and the concentration of mercury in the blood (Fig. 17-8) are adequate expressions of dose, at least under conditions of long-term intake (months).

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Treatment of Mercury Poisoning

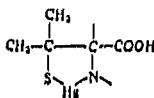
As was pointed out in the discussion of the treatment of lead poisoning, data concerning the relative efficacy of various approaches to the treatment of metallic poisoning in general are grossly inadequate. The treatment of mercury poisoning is no exception. Studies of therapeutic regimens conducted on man generally are limited to clinical reports on one or, at most, a few individual cases with one or another selected drug. The reader, and the investigator himself for that matter, are always left to ponder questions concerning what would have happened had the patients not been treated at all, or concerning what would have happened if some alternate drug or regimen had been used. Even when a substantial number of cases is available to a single investigator, ethical considerations severely limit the options. Untreated controls cannot be included in the study if the condition is even moderately severe. Reliance on data from experimental animals is equally unsatisfactory for various reasons. The experimental design may not correspond to the usual human exposure situation or the animal model selected may not behave like man.

Chelating agents are relied upon, as in the case of lead poisoning, to remove mercury from the body. For many years the only chelating agent known to promote the excretion of mercury was dimercaptopropanol (BAL). It has been shown repeatedly that it enhances the excretion of mercury administered experimentally to animals in the inorganic form. It has also been shown to be beneficial in the treatment of inorganic mercury poisoning in man, enhancing the excretion of mercury and effecting substantial improvements in the patients' clinical status. Its efficacy has been attributed to the presence of thiol groups on adjacent carbon atoms, with the presumed participation of both in the binding of divalent mercury as a stable, readily excreted chelate ring.



Dimercaptopropanol, however, had two drawbacks. It was ineffective when given orally and it was ineffective as an antidote against alkyl mercury compounds. The next major advance was the discovery that the amino acid penicillamine was an effective chelator for mercury, even when administered orally. Its activity as a chelating agent is attributable to ring formation in which the thiol and primary amine groups probably serve as coordination sites.

More recently, the N-acetyl derivative N-acetyl-D,L-penicillamine (NAP) has been discovered to be even more effective and less toxic than D,L-penicillamine. The toxicity of D,L-penicillamine



is attributable to the L-isomer, which inhibits a number of pyridoxine-dependent reactions, probably by reacting with pyridoxal-5-phosphate to form a thiazolidine. By contrast, the D-isomer of NAP is relatively nontoxic. The LD₅₀ of D,L-NAP is considerably greater than for D,L-penicillamine or even than for D-penicillamine.

The concept of ring formation, with the attendant stability of the metal complex, suggests that compounds of the type R-Hg²⁺, such as methyl mercury, would not form metal chelates with BAL or NAP. Surprisingly, NAP enhances the excretion of methyl mercury to a very substantial degree. It may be speculated that this effect is due only to interaction with Hg²⁺ formed by *in vivo* dealkylation of methyl mercury. This is unlikely, since NAP also removes methyl mercury bound to serum albumin *in vitro* (Aaseth, 1976). An alternate possibility is that NAP first causes a cleavage of the carbon-mercury bond and subsequently reacts with Hg²⁺. It has been demonstrated that sulfhydryl reagents such as glutathione enhance the cleavage of the carbon-mercury bond of phenyl mercury *in vitro* in the presence of γ-globulin (Cage, 1975). It is not inconceivable, therefore, that NAP might facilitate a similar cleaving action on the carbon-mercury bond of methyl mercury.

In spite of some impressive animal data concerning the efficacy of the penicillamines as mercury chelators, their clinical efficacy in the treatment of methyl mercury poisoning is not impressive (Bakir *et al.*, 1976). To a large extent at least, this is because the neurologic effects of methyl mercury result from irreversible damage to neurons. Even from the more limited point of view of metal-mobilizing efficacy, the results have been equivocal. In some cases there has been essentially no suggestion of metal mobilization, at least insofar as decrease in blood mercury levels is concerned.

CADMIUM

Introduction

Cadmium ranks close to lead and mercury as a metal of current toxicologic concern. It is a relative newcomer, having been identified as a distinct element only in 1817. It occurs in nature